THE annual volume of Papers of the Michigan Academy of Science, Arts and Letters is issued under the joint direction of the Council of the Academy and of the Executive Board of the Graduate School of the University of Michigan. The editor for the Academy is Paul S. Welch; for the University, Eugene S. McCartney.

Previous publications of The Michigan Academy of Science now known as The Michigan Academy of Science, Arts and Letters, were issued under the title, Annual Report of the Michigan Academy of Science. Twenty-two volumes were published, of which the first five are out of print. Copies of volumes numbered six to twenty-two are still available for distribution and will be sent on exchange so long as the editions last. Applications for copies should be addressed to the Librarian of the University of Michigan.

Annual Reports embracing the proceedings of the Academy will however, continue to be published.

MICHIGAN ACADEMY OF SCIENCE, ARTS AND LETTERS

VOLUME I

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1921

THE MACMILLAN COMPANY
NEW YORK BOSTON CHICAGO
ATLANTA SAN FRANCISCO

MACMILLAN & CO., Limited
LONDON BOMBAY CALCUTTA
MELBOURNE

THE MACMILLAN CO. OF CANADA, Ltd.
TORONTO

PAPERS

OF THE

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

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UNIVERSITY OF MICHIGAN

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New York
THE MACMILLAN COMPANY
LONDON: MACMILLAN & COMPANY, Limited
1923

Set up and printed,
February, 1923

PRINTED IN THE U.S.A.

NOTE

THE present volume of scientific papers is the first in a new series of publications of *The Michigan Academy of Science*. The twenty-two volumes which have been known as the *Annual Reports of the Michigan Academy of Science*, have been published under special appropriations of the State of Michigan. In 1921, however, the Academy and the University entered into an agreement for the annual publication of the Academy's papers. The new plan, involving a complete change in the form of the volumes as well as a change of title and involving also inclusion in the University's general program for scholarly publications, is inaugurated with the present volume.

The scholarly publications of the University are all under supervision of the Executive Board of the Graduate School. In respect to the papers of the Academy the editor for the Board will work in collaboration with the editor for the Academy. Unfortunately, circumstances have combined greatly to delay the first volume, but hereafter prompt publication may be expected.

It will be noticed that the volumes for 1921 and 1922, the latter to appear in course of the present academic year, contain no papers in arts and letters in spite of the new and more comprehensive name of the Academy; but sections in the humanistic subjects are now contemplated, their organization will soon be effected and subsequent volumes should show the new fields of interest and activity.

Finally, the University has welcomed the opportunity to establish closer relations with the Academy in its efforts for higher scholarship, original investigation and important contribution.

ALFRED H. LLOYD

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HARLEY HARRIS BARTLETT

INTRODUCTION

In 1918, while located in Asahan, East Coast of Sumatra, the writer made ethnological observations which will provide material for a series of disconnected articles, in the first of which the reader will find general remarks on the region and its population.[1] This second article is concerned with burial, and particularly with a very interesting symbolic grave-post, called the *anisan*,[2] which appears to be no longer in use except among the Batak of Asahan and the adjacent Simeloengoen district of Tanah Djawa.

As far as can be ascertained, the meager literature bearing on this region contains no reference to the anisan. If it has been noticed at all by previous visitors, it has doubtless been taken for the ordinary Malayan grave-post, the *nisjan*. The form of the anisan which is used to mark the graves of men does, indeed, have the most superficial resemblance to the Malayan nisjan, but the forms used on the graves of women are totally different.

The area in which the Batak anisan occurs is small. The native culture has been badly shattered by the progress of

[1] H. H. Bartlett, *The Manufacture of Sugar from Arenga saccharifera in Asahan, on the East Coast of Sumatra*, *Ann. Report Michigan Acad. Sci.* 21: 155–165. Plates III–VI. 1920.

[2] The Malay and Batak words used in this article, except those in titles or quoted passages, are spelled according to the system current in Netherlands India. The vowels have the usual continental pronunciation except that *oe* is equivalent to *u*. This is the only objectionable feature of the Dutch system, which prevails so much more widely, and is used for so many more Indonesian languages than the English system, that it should be generally adopted. There are no peculiarities in the pronunciation of the consonants: *ng* is always pronounced as in the English word *singer*; *dj* is the English *j*; *j* is the English *y*.

Islam and by the incoming, with the development of great European and American plantations, of thousands of coolies of alien speech and custom. It is not altogether easy for a transient visitor to the plantation districts of the East Coast to discover a great deal about the manners and customs of the indigenous population. Probably all the elements of the old pagan culture still exist, generally in incongruous association with innovations, but any complete view of things as they were even twenty-five years ago can only be had by imaginative synthesis. The old grave-posts are rapidly going out of use, as the natives attempt more and more to live in a manner outwardly conforming with Malay usage. Those that remain are rapidly being eaten by termites. A very few only, none of them in Asahan, are of stone. Typical examples were photographed at every locality where it could be found that any remained, but on account of the quite understandable scruples of the natives, specimens were not secured. The area in which the anisan occurs is one in which place names and tradition point to pre-Islamic foreign colonization. Who the colonists were can only be surmised. They may have come directly from India, or they may have been Javanese, or more likely Menangkabau Malays with at least a veneer of Hindu civilization. Whoever they were, it was their fate to be assimilated to the indigenous Batak population, leaving as their memorial certain culture elements, among which was the symbolic grave-post.

The most important bearing of the anisan, the writer believes, is in the interpretation of the origin and symbolism of Indic religious architecture. If the speculations on this point hold good, the anisan is to be looked upon as a survival, at one of the outposts of ancient Hindu colonization, of an Indic grave structure which in India itself, *pari passu* with the abandonment of earth burial, has developed into higher architectural forms and ceased to exist. It supplies new evidence favoring the theory that the Hindu temple developed from a grave shrine. As will be seen, the Hindu temple has at least some of the structural elements of the Batak grave. Since the latter symbolizes earth, fire, food, and water, a comparison is at once

suggested with the elemental *stupa* of Buddhism, which, in modern forms, symbolizes earth, water, fire, air, and ether. Can the stupa have had a common origin with the Hindu temple? Is the Batak grave a surviving archetype of both? The writer believes that both questions may be answered in the affirmative.

William Simpson,[3] who wrote on the origin of Hindu temple architecture and of the worship in the temple, apologetically remarked: "It must be confessed that I do this with considerable diffidence, because I am but very slightly acquainted with the sacred books of the Hindus, and I may have the Pundits quoting the Sutras, the Brahmanas, and the Puranas, and overwhelming me with texts, — a fate that often befalls those who venture beyond the limits of what they know." This quotation depicts the writer's state of mind perfectly. Whatever speculations may prove to be ill-founded, however, will not mar the value to others of the raw data presented in this article.

DESCRIPTION AND DISTRIBUTION OF THE BATAK ANISAN

In Asahan the grave of a Batak of consequence is marked by a rectangular mound, a foot or two high, held by retaining walls of horizontal boards or vertical palings. It may or may not be sheltered by a *djirat* or grave house,[4] which, if present, is placed east and west, at right angles to the great house of the *radja*, which is placed north and south. In Tanah Djawa there is nearly always a *djerat*, following the same rule as to orientation. (See Plate XIV, Fig. 1.) The mound itself is known generally by the Arabic-Malay word *koeboer*, but in the Toba and Asahan dialects the native word *tanoman* is also used. At the center

[3] Wm. Simpson, *Some Suggestions of Origin in Indian Architecture, Journ. Roy. Asiatic Soc.*, N.S., 20: 49–71. 1888.

[4] Malay and Asahan dialect, *djirat;* Simeloengoen and Karo, *djerat;* Gajo, *djeret;* Toba, *djoro;* — all probably from the Arabic *ziarat*, although the Toba word has a close resemblance to the Balinese *djero*, house. There is also a true Batak word *pondom* which is nearly displaced by the word derived from the Arabic. In Atjeh, according to Snouck Hurgronje (see footnote 41), the grave itself is called *jeurat*, a term used generally by Muslims to denote the graves of unbelievers.

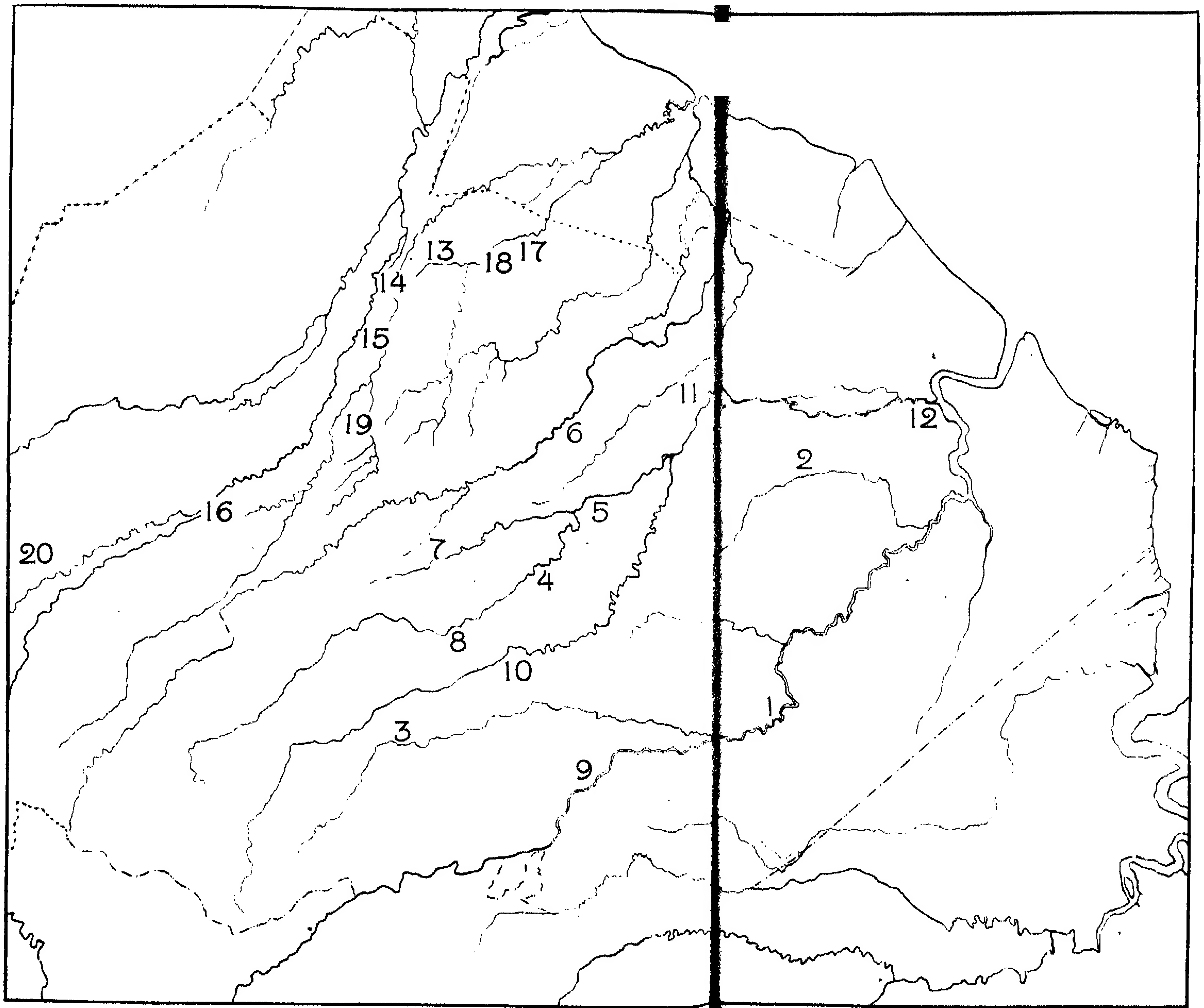
of the mound is a small square, its axes at angles of 45 degrees to those of the mound, retained by sides only an inch or two high. This is the *dapoer*, or hearth. At each corner the hearth frame is held in place by three notched sticks, *partoenggoel*, the notches resembling those of the log which is frequently used as a house ladder. The word *partoenggoel* means merely a support, but the notches suggest a function similar to that of the soul-ladders used by the Jakun of the Malay Peninsula, who provide the spirit with a means of leaving the grave when it desires to do so.[5] At the center of the *dapoer* is the anisan, or post.

The anisan is elaborately carved. The apex, if the grave be that of a man, represents a common gourd or earthen water-jar with constricted neck, both of which objects are known as *taboe* (cognate with Malay *laboe*). This is the only item in the series of carvings which each native informant instantly recognized and gave the same name for. The other carvings were said by some to represent a set of receptacles for the constituents of *sirih* (pepper leaf, betel-nut, and lime), and also cooking utensils and food. Others said they did not know anything about the carvings except that they "ought to be correctly made." There was fair uniformity in denominating the round object below the water-bottle as *boewa galoegoer*, a certain sour fruit, probably that of a species of Garcinia, and the triangular ornaments as *ipon-ipon*, literally meaning teeth, but also the name for a design consisting of rows of triangles.

Further details of construction show so many variations that the reader will do well to follow the remainder of the description in Plate I, which represents a grave that the natives agreed was correctly made. Moreover, it was the only pagan grave of all those seen that had been kept in perfect condition.

The base of the anisan is round in cross-section. It is followed by a circular plinth bearing eight lotus-petal ornaments. Above these the post is octangular to about the middle, where there are two eight-petalled lotus flowers with the tips of the

[5] W. W. Skeat and C. O. Blagden, *Pagan Races of the Malay Peninsula* (London, 1906), Vol. II, p. 114.



A. Localities in Asahan

a. Batak grave-post seen
1. Poeloe Radja ♂ and ♀
2. Hesa Lama ♂ and ♀
3. Haboko ♂
4. Boentoe Pane ♂
5. Poeloe Mandi ♂
6. Silo Maradja ♂ and ♀

b. Batak grave-post reported
7. Pinggan Merdjawa
8. Bandar Pasir Mandoge

c. Seated grave images seen
2. Hesa Lama (wood) ♂
6. Silo Maradja (wood) ♂
9. Bandar Lama (stone) ♂ and ♀
10. Koeta Boerhoe (stone) ♂

d. Seated grave image reported
7. Pinggan Merdjawa (wood) ♂
11. Goeroe Batoe (stone) ♂

e. Malayan (i.e., Muslim) nisjan used
12. Tandjoeng Bale

B. Localities in Tanah Djawa

a. Batak grave-post seen
13. Goenoeng Mĕligas (wood) ♂ and (stone) ♀
14. Bahal Batoe (wood) ♂
15. Radja Mĕligas (wood) ♂ and (stone) ♀
16. Pĕmatang Tanah Djawa, (wood) ♂ and (stone) ♀

b. Batak grave-post reported
17. Koeboean (wood) ♂
18. Bĕsar Mĕligas (wood) ♂
19. Parboetaran (wood) ♂

c. Tumulus burial without carved grave-post
20. Sĕriboe Lawan

Outline Map of Asahan and Tanah Djawa, Showing the More Important Localities Mentioned in the Text.

petals opposed to one another. To this point the ornaments were supposed to represent the *sirih* set, but no native whom I had an opportunity to question could particularize further. Above the middle, the post is usually circular in cross-section; a circular disk is followed by a second pair of opposed eight-petalled lotus blossoms. This pair are said to represent teeth, *ipon-ipon;* then follow another disk and the globular object called the *boewa galoegoer;* a third disk bears a single upright lotus flower, the natives hazarding the opinion that it may be a cup (*mankoek*); a final disk is surmounted by the water-bottle (*taboe*), obviously such, as indicated by form and name.

Needless to say, it is the writer, influenced by the Indic analogies of the anisan, and not the natives, who is responsible for the identification of the lotus ornamentation. Although eight is the number usually preferred by the natives in carving the *ipon-ipon,* one post was seen with only four teeth in a set (Plate III, Fig. 1) and many posts had numbers greater than eight, particularly those of female form, which are of greater diameter than the male posts. The prevalence of eight probably indicates that the posts were formerly oriented with regard to the cardinal and intermediate points of the compass.

The anisan on a woman's grave is very different from that on a man's. The base is similar, but much of the intermediate ornamentation may be lacking, and the water-bottle at the apex is replaced by a bowl-shaped object for which I could get no definite name, although most of the natives thought it was a cooking pot (*parioek*). It may perhaps be interpreted as a water-vessel shaped like the fruit of the lotus. On the grave of a woman of high rank the *parioek* is surmounted by a miniature house. (Plate VI, Fig. 2.)

In burial, as in other matters, the Batak of the coastal districts now tend to follow Muslim usage. The old graves described in this paper were found at a number of localities, as may be seen from the accompanying sketch map (No. 1), but they were mostly in bad repair, from the ravages of termites. In Asahan, graves were photographed at such distant points as Poeloe Radja, on the Asahan River, Simpang Kawat (for-

merly Hesa Lama) near Tandjoeng Bale, both near the southern border of Asahan, Haboko, far inland toward the mountains, and Silo Maradja, Boentoe Pane, Poeloe Mandi, and other *kampongs* in the north of Asahan. In Tanah Djawa the anisan was seen at Goenoeng Mĕligas, Bahal Batoe, Radja Mĕligas, and Pĕmatang Tanah Djawa. It was frequently impossible to get a photograph because the grave was covered by a grave house. At Koeboean and Bĕsar Mĕligas it was said that the anisan was still in use, but when the burial places were visited under the guidance of natives the posts were found to have rotted away. At kampongs in the Simeloengoen country outside of the small area included in the above range of distribution, the anisan was not found. At Sariboe Lawan, for instance, a recent grave (Plate XXI, Fig. 2) was found to consist of a mere conical tumulus of earth at the edge of which was an uncarved bamboo pole, bearing *roedang* (a ceremonial plant, in this particular case an inflorescence of the *pinang*, or betel-nut palm). This particular grave was that of a woman (the mother of the man shown in the illustration), but I was assured that the grave of a man was not different.

At Simeloengoen kampongs bordering on Toba Lake the anisan was not found, although looked for and inquired about at Tiga Ras and at Panahatan, Tandjoeng Dolok, and neighboring kampongs. It was not found at Pĕmatang Siantar and Naga Hoeta. On the road from Batoe Bara to Siantar fruitless inquiries were made at Pĕrdagangan and elsewhere. Although the value of negative evidence obtained by a casual visitor should be discounted somewhat, it appears likely that the area of the anisan in Tanah Djawa is not much more extended than the known localities indicate.

In Tanah Djawa no modern wooden anisan of the female form was found, but ancient ones exist in stone, of which one may venture to suspect that they have been used for successive burials, since they are now said to mark the graves of men. (Plates XVIII and XIX.) In the same region there are also stone posts surmounted by a miniature house, but lacking the bowl-shaped object at the top, and sometimes without the lotus

flower ornamentation. They are now either found standing alone in the kampongs, not having been used for any recent burial (as at Pĕmatang Tanah Djawa), or else they are associated with the stone posts of typical female form, one being placed at the head and the other at the foot of the same grave (as at Radja Mĕligas; see Plate XIX). Modern graves of women have posts of the male form, but with a different *topeng*. (See Plate XX, Fig. 3.)

The practical disuse of the female form of the anisan in Tanah Djawa marks the principal regional difference in burial usage from Asahan. The more frequent use of the grave house, or djerat, in Tanah Djawa has already been mentioned. In Tanah Djawa the Malay practice of having two posts on the same grave is being adopted, whereas in Asahan the grave has the post at the center, or, if the grave is that of a radja, whose image occupies the center of the mound, there are four anisans, one at each corner. The primitive Batak practice is to use one post, and two posts on a grave are a sure sign of Muslim influence. Regional differences in the male anisan will be obvious from the specimens chosen for illustration, when it is explained that the one from Tanah Djawa shown in Plate XVII, Fig. 1, is typical for the district, differing from the Asahan type in the substitution of a diamond design for much of the lotus flower ornamentation. That the difference is not of recent origin is shown by the fact that the old stone posts of female form sometimes have the same diamond design as the modern wooden male posts.

Only one old stone post was seen in Tanah Djawa which seemed to be of the male fôrm, and it was broken at the apex and so aberrant in sculpture as to raise a doubt as to whether it had originally been made to serve as a grave mark. Since someone else may be able to throw light upon it, a photograph is included among the illustrations. (Plate XVII, Fig. 2.)

ACCESSORIES OF THE BATAK GRAVE

The Batak is not content with offering to the dead mere symbols, as represented in the carved anisan, but he also places real articles on the grave. A half of a cocoanut shell, half-filled with ashes from the hearth, upon which rest a few glowing embers, broken dishes containing rice and other foods, and a gourd or broken earthenware bottle, containing lemonade or water, are placed upon the fresh grave. The dishes are broken, so as to free their spirits to serve the spirit of the dead. This statement was definitely made by several natives, but was disputed by others, who said that the articles were broken because perfect ones would surely be stolen by thieving coolies from the plantations. The former explanation would seem almost surely to be the correct one. (See; however, footnote 14.)

Over the grave, diagonally between poles at two corners, is stretched a cord, *pakireon*, upon which is hung an old cloth, *kain boeroek*, one which belonged to the dead man. On this cord is also hung the lower jaw (*osang-osang*) of the first wild hog that can be killed after the funeral. (Plates I, Fig. 1, and III, Fig. 2.)

On feast days the grave dishes are replenished with food, and *sirih* and cigarettes are tucked into the carved *ipon-ipon* of the anisan. On one occasion a native visited the long-neglected grave of one of his family with me, and as an act of filial piety placed his freshly lighted cigarette in the post. As we left the spot, he looked back ruefully, and finally decided to retrieve his offering, saying that smokes were high, and, anyway, he would be *Islam bĕtoel*, — true Muslim.

Rough effigies of various useful objects are frequently carved in soft wood, and put upon the grave. On the grave shown in Plate IV, Fig. 2, was a replica of a gun. This grave was unique among those seen by me in that the water-jar of the anisan was surmounted by a bird,[6] perhaps for the *djinoedjoeng*,

[6] Interesting parallels of the anisan with a bird at the top are found in Borneo and in Burma. Among the Olo Ngadju, a Dyak group, a mast about 18 feet long, the *sanggaran*, is erected near the coffin. At the middle

a supplementary external soul, which has the function of a guardian angel. The *djinoedjoeng* is said to appear sometimes in the form of a bird, or to reside in a bird. Lying upon the same grave was a roughly carved figure of a human being, not carefully enough made to indicate the sex.

At the center of a radja's grave it was formerly customary to place a life-size image of the deceased, sitting cross-legged. In recent times such images have been made only of wood, as for example those to be seen at Hesa Lama and Silo Maradja (Plate VIII), but similar ones of stone are found at ancient kampong sites in the jungle, and are reverenced as the abode of powerful spirits. Hadji Moehamat of Bandar Poeloe kindly guided me to the images at Bandar Lama, shown in Plates IX and X, and others, which stand on a hill at Koeta Boerhoe, near where the road crosses the Aek Piasa, were discovered by Mr. P. A. Moorees, while Controleur of Asahan. (Plates XI, XII and XIII.) There was formerly such an image on a sacred hill (*boekit karamat*) at Goeroe Batoe, from which the estate called Goerach Batoe takes its name. Although this image was greatly reverenced by the natives, it was removed by a certain Dutch estate-manager, who is said to have brought coolies and personally superintended the packing of the stone in a box, as though for shipment. I called upon him, and asked if a photograph was available, but he denied vigorously that such an image had ever existed! The testimony of the natives regarding the matter seemed more trustworthy.

All the stone images that were definitely, by tradition,

is a large earthenware jar with the bottom knocked out, through which the mast passes. At the apex a wooden bird is fastened. The *sanggaran* is erected at the funeral festivities, in the belief that the soul of the *sanggaran* will secure to the departed all sorts of riches in the spirit world. It is interesting that the word *gana*, in this connection translated as "soul," is the Batak word for image, and is especially used in Batak to designate images having some function in dealings with gods and spirits. (A. Hardeland, *Dajacksch-Deutsches Wörterbuch* [Amsterdam, 1859], p. 505, "*sanggaran.*") The Karens of Burma, as shown in a popular book on Burma, by a photograph which is unfortunately not referred to in the text, erect over the grave a small house, surmounted by a pole which bears a bird at the top. (Max and Bertha Ferrars, *Burma* [London, 1900], p. 156, Fig. 351.)

grave marks and not *pangoeloebalangs*,[7] were found in Asahan. None were seen in Tanah Djawa, although I heard of some that had been removed from the latter district by an estate-manager and were said to stand in front of his house (probably with a tidy coat of white-wash!) somewhere near Siantar. I never found time to trace them.

Finally, the very interesting custom must be mentioned of hanging on the anisan of a chief, or in the grave house above it, a wooden mask, called *torping* in Asahan, and *topeng* or *toping* in Simeloengoen and Toba. The custom is preëminently one characteristic of the Simeloengoen Batak, and extends beyond the area in which the anisan is used. As will be seen, in Simeloengoen the *topeng* is laid on the grave mound if there is no post on the grave, or, in the district bordering on Karoland, it is kept in the radja's house, and not placed upon the grave at all. In Asahan the mask is no longer used in most of the kampongs, and where it has been, recently, it is found hanging up in the grave house. The *topeng* seems to indicate a former custom of offering human sacrifices, slaves dedicated to their master to accompany him in the spirit world, and a prevailing tradition has it that such sacrifices have not been long in disuse. The *topeng* may be looked upon as a ceremonial substitute for a man, which enables subsidiary chiefs, at the funeral of a very great radja, to aver their allegiance to their former lord even in death.

The information which I was personally able to get with regard to the *topeng* was that when a member of a radja's family died, a common man or a slave danced at the funeral, wearing the mask.[8] He was not necessarily killed, since the magical ceremonies gave his spirit to the deceased whether he was killed or not. The Asahan people said that it had never been their custom to kill the dancer, but that the Simeloengoen people did. The Simeloengoen people just reversed the story.

[7] As the term *pangoeloebalang* is used in Tanah Djawa it means an image endued with soul-stuff (*tondi*) by sacrificial ceremonies, and used in magic.

[8] See Excursus I at the end of the article.

In Tanah Djawa the masks were made with little conventional differences to distinguish those of men and women (See Plate XX) since there was sometimes a female *topeng* dancer at the funeral of a woman.

Excellent figures of a pair of Timoer (i.e., Simeloengoen) masks, unfortunately without exact locality data, are to be found in the catalog of the Leiden Ethnographic Museum.[9] The description of the plate quotes a lengthy and valuable note by Controleur W. C. Van Gelder[10] from which the following account is summarized: The masks are used at the ceremonies accompanying the burial of a chief. The word *topeng* applies not only to the mask itself, but to the person who wears it. The *topengs* are a sign of allegiance of the different vassal chiefs who participate in the ceremonies. Each vassal brings his own *topeng* to the kampong where the funeral festivities are held, and is greeted at his entry by the *topengs* who have already arrived, who meet him dancing. In the *topeng* dance at the funeral of a radja, only men take part. The number of *topengs* at the burial of the Radja of Tanah Djawa might be seventeen, at that of the Radja of Raja, eleven, the number depending upon the descent of the ruling chief, and also upon the number of visitors bearing *topengs*. The *topengs* dance unceasingly as long as the orchestra plays; when it ceases, the *topengs* stop but the dance must then be taken up by those in the house. When the coffin of the deceased radja is borne from the house, the dancing *topengs* precede it to the grave. When the coffin has been lowered and the grave filled, the masks are placed upon the grave mound, and must never be removed. Violations of these customs will bring death into the ruling family. Those who carry out the *topeng* dance on the day of a burial are sprinkled at the river by the village magician (*goeroe*) in order to remove evil influence from them.

From the fact that Van Gelder's account makes no mention

[9] H. W. Fischer, *Catalogus van 's Rijks Ethnographisch Museum*, VII. *Bataklanden*. Leiden, 1914. (See Plate IX and description on pp. 120–121.)

[10] Perhaps derived from the following article not accessible to the writer: W. C. Van Gelder, *Een vorstelijke begrafenis in de Bataklanden*. Eigen Haard, 1912.

of a grave-post, but merely of a mound, one may fairly conclude that his observations were made in one of the states other than Tanah Djawa. The usages described do not agree exactly with the customs farther north, as described by Hagen (See Excursus I, p. 49), nor with the writer's notes. The discrepancies are not at all hard to understand, however, when it is remembered that Van Gelder's account refers to the funeral of one of the very highest chiefs, to whom the other chiefs would devote themselves symbolically through the *topeng* ceremony, whereas the graves observed by the writer, with one or at most two masks, were those of members of the radja's family, or minor chiefs, whose dignity demanded only that one or two slaves do the *topeng* dance.

It seems very reasonable to suppose that the *topeng* is a substitute for a human sacrifice. The workings of the Indonesian mind in regard to this matter are shown by the recent change of custom on the island of Nias. It was formerly the custom for a chief to determine, before he died, how many heads should be struck off at his funeral. Under the Dutch régime, wooden heads are used instead. A figure of one of them is given by Kleiweg De Zwaan.[11] (This topic is mentioned again in Excursus I, p. 49, and footnote 19.)

The Batak appear to have regarded the water-bottle as the most essential item of the grave furniture. A gourd will be found upon a fresh grave even if everything else is lacking. In the old days the graves of chiefs were distinguished by the use of special highly ornamented clay bottles, which seem not to have been used for ordinary household purposes. These bottles have become exceedingly rare. One was found still in place on the grave of a former radja of Silo Maradja, and a second on the grave of a chief in the vicinity of Poeloe Mandi. (See Plate VII, Fig. 2.) The art of decorating these bottles, by incision of the unburned clay with a knife, reached a high degree of perfection, as may be seen from the photographs of these two examples.

[11] J. P. Kleiweg De Zwaan, *Die Heilkunde der Niasser*. Haag, 1913. For an account of head-hunting, in relation to the ancestor cult, see pp. 23–35.

The ware is unglazed, like all Batak pottery, and very imperfectly burned, but it makes up in beauty of design for what it lacks in ceramic technique. A few of the old chiefs in the back country of Asahan are said to have inherited, and to hold in reserve for their own graves, such earthen water-bottles as those illustrated. They were not seen at all in Tanah Djawa.

The writer has no wide acquaintance with Indonesian pottery, but has seen nothing similar in style to the Asahan ware except certain examples of recent manufacture from Padang Lawas, the only part of the Batak area where there is abundant archeological evidence of ancient Hindu occupation. The artistry of the grave pottery shows Hindu influence, and the custom of placing a jar on the grave is likewise Indic. The placing of an actual jar upon the grave, in addition to representing it on the symbolic grave-post, taken in conjunction with the greater range of the use of the real jar, may indicate two different ethnic waves from the continent, one more ancient, or at any rate more primitive, than the other.

Outside of our area, many examples might be cited of the custom of placing a water-jar upon the grave. As we leave, for the time being, the discussion of the custom as far as India is concerned, it will suffice to cite a few examples in Indonesia.

In Koewaloe, south of the Asahan River, where the carved anisan is not known to be used, a pyramidal, stepped grave is built up by filling successively smaller wooden frames, placed one upon another, with earth. On top is placed a clay water-jar. Such a grave is figured by Volz.[12]

Neumann[13] gives an excellent account of burial customs in the southern Batak districts. After the filling of the grave a

[12] W. Volz, *Nord-Sumatra*, Band I, *Die Bataklãnder* (Berlin, 1909), p. 176. "Interessant waren mir im Urwald zwei Batakgräber, die beide aus vier Stufen bestanden, jede aus vier Brettern zusammengesetzt, deren Vorder- und Hinterenden einen Menschenkopf mit Ohren und Tiermaul zeigten. Obenauf lag ein zerbrochener, irdener Topf; orientiert waren die Gräber etwa OW (Abb. 59)." From Volz's figure, the writer is inclined to view the carvings as horses' heads. (See Excursus I, p. 49.)

[13] J. B. Neumann, *Het Pane- en Bila-stroomgebied op het eiland Sumatra.* (Articles assembled from *Tijdschrift van het Nederlandsch Aardrijkskundig Genootschap.*) *Derde afdeeling, derde boek*, p. 501.

cubical eminence of earth and stone (*nesan*) is erected over it, on which the bier is placed. As soon as everything is ready, the horns, brains, tongue, and other portions of a water buffalo are laid on the bier (*rapotan*) while words to the following effect are spoken by one of the old persons: "Here is food for you, ghost Lanok marsihampar. It is the food of us men, and as hard to use up as the fruit of the *otal* tree." In addition, water is placed on the grave in a jug, and rice on a plate, and rice meal (*tombo-tomboan*) and cooked rice are hung in a sack above the *rapotan*. Finally, a broken plate, a broken bowl, a broken drinking cup, and a broken cooking pan are left upon the grave. Neumann states that these articles are broken on the *nesan*, and adds that he does not know why they should have to be broken.[14]

Among the pagan Donggo of the island of Sumbawa there are five exogamous groups, of which only one is distinguished from the rest by the grave mound being round. The other graves are presumably rectangular. Some of the round graves are figured by Elbert.[15] He says that after the heaping up of the grave mound an offering is made to the god of heaven, Dewa Langi, the priest suspending from a post a hanging pot containing *sirih* and betel-nut. Then, for the soul of a man, a woven basket of *sirih* and a water-crock are placed upon the grave; for a woman the *sirih* and betel, with sometimes part

[14] On p. 8, the alternative explanations offered by the natives for the breaking of the grave dishes in Asahan have already been mentioned. The writer has expressed his preference for the explanation that seems most natural among an animistic people, namely, that the breaking releases the soul or spirit of the article, thus corresponding to the death of a living being. It may be noted that among an animistic group in Borneo the same custom has been observed, and the other explanation preferred. "Among Klementans it is usual to spoil all articles hung upon a tomb; and they give the reason that in the other world everything is the opposite of what it is here; the spoilt shall be perfect, the new and unspoilt shall be old and damaged, and so on. It is probable that the real or original motive for this practice is the desire to avoid placing temptations to theft in the way of strangers." C. Hose and Wm. McDougall, *The Pagan Tribes of Borneo* (London, 1912), Vol. II, p. 36, footnote.

[15] J. Elbert, *Die Sunda-Expedition des Vereins für Geographie und Statistik zu Frankfurt am Main* (Frankfurt am Main, 1912), Vol. II, p. 71, and Plate IX, Fig. 2.

of the loom. As far as can be made out from Elbert's excellent photographs, the earthen water-bottles are not broken.

As a final Indonesian example of the use of the water-jar on graves, we may advert to the Dyak *sanggaran*. The latter structure is of especial interest from the standpoint of the origin of the anisan, representing possibly a still earlier stage of development, since it is a grave-post in which an actual earthen jar is structurally incorporated. It shows other points of similarity to the anisan in that it appears to be often eight-sided, and ornamented with lotus motives.[16] (The bird at the top has already been mentioned, footnote 6, as having Batak and Karen parallels.) It is the name of the *sanggaran*, however, which proves its Hindu origin most conclusively, for in Bali, the only remaining outpost of Hinduism and Buddhism in the Indian Archipelago, the household temples, some of them dedicated to Siva, but most of them to the *pitaras*, the shades of the dead, are called *sanggar*.[17] The final *-an* of the Dyak word is merely a formative which makes it mean "place of the *sanggar*." During the Hindu period in Indonesia the Hindu influence extended to Borneo, as we know from abundant evidence. Just as in Sumatra, customs of a relatively high culture fused with the more primitive aboriginal customs. From the standpoint of the origin of the Batak *topeng*, it is interesting to find that there is evidence that in Borneo the cult of the dead gave rise to the custom of head-hunting. We have an interesting old account by a wrecked Japanese sailor, Magotaro,[18] of the placing

[16] H. H. Juhnboll, *Catalogus van 's Rijks Ethnographisch Museum, Deel II, Borneo, Tweede gedeelte* (Leiden, 1910). See p. 346, and also Plate XXIV, Fig. 1, in which the excellent phototype shows that the post below the jar is carved with lotus designs and resembles the anisan considerably in general appearance.

[17] R. Friederich, *An Account of the Island of Bali*, in *Miscellaneous Papers Relating to Indo-China and the Indian Archipelago, Second Series*, II, pp. 69–200 (London, 1887). The *sanggar* is referred to on p. 101.

[18] W. G. Aston, *Adventures of a Japanese Sailor in the Malay Archipelago, A. D. 1764 to 1771, Journ. Roy. Asiatic Soc.*, 1890, pp. 157–181. (Abridged from a Japanese book entitled *Nankai Kibun*, 'Notes of the Southern Ocean.') "Ten days or more up the river from Banjar Masin, there is a place called Wyaja, which is not subject to Kaitan . . . It is the custom of this tribe, on the death of a parent or relative, to cut off a man's head

of a human head on Dyak grave-posts, and more modern data are given by Hose and McDougall.[19]

In brief, the writer's view of the anisan is that, even though it may have already come to possess an esoteric symbolism beyond the reach of the Batak at the time it was introduced, they grasped its fundamental significance as representing things useful to the dead. It seems to have originated among people in India with very similar customs to those of the pagan groups of Indonesia. The latter have preserved, in their funeral rites, customs very similar to those which in India led to the development of the anisan itself. It was doubtless the vagueness of their ideas as to the exact significance of the different parts of the anisan that prevented the substitution of the anisan for actual grave furniture such as they still place upon the grave.

In urging the equivalence of the Batak grave with such a form as the elemental stupa, the writer does not wish to gloss over the fact that the Batak is exceeding vague in his interpretation of parts of the anisan. There is no doubt about the identification of the water-jar. The equivalence of the *dapoer*

and make an offering of it at the funeral, when it is set up at the grave on the top of a piece of wood carved into the shape of a serpent. If this is not done, they think that the dead person will send a curse on them." With regard to the piece of wood carved into the shape of a serpent Magotaro's observation is probably quite dependable, for the *sanggaran* as described in the Leiden Catalogue has a cross piece above the jar in the form of a dragon.

[19] C. Hose and Wm. McDougall, *The Pagan Tribes of Borneo*, Vol. I, p. 189. "A second plausible view of the origin of head-taking is that it arose out of the custom of slaying slaves on the death of a chief, in order that they might accompany and serve him on his journey to the other world. We have pointed out several reasons for believing that this practice was formerly general, and that it has fallen into desuetude, but is hardly yet quite extinct. . . This second suggestion is strongly supported by the fact that the Kayans, Kenyahs, and Klementans occasionally, on returning home from a successful raid, will carry one of the newly taken heads to the tomb of the chief for whom they are mourning, and will hang it upon, or deposit it within, the tomb beside the coffin. The head used for this purpose is thickly covered with leaves (*daun isang*) tied tightly about it. It is possible that this thick covering was first applied in order to disguise the fact that the head is that of an enemy, and that the sacrifice of the life of a domestic slave, originally demanded by custom and piety, has been avoided by this process of substitution."

with the household hearth is sufficiently evident, both from its construction and its name. The Malayan hearth is a square frame of boards filled in with earth, and is used by practically all of the peoples of the Archipelago and Peninsula. The use of a square, framed grave, called *tanah mati*, land of the dead, the surface of which is called the hearth, is widespread. In commenting upon such a grave among the Jakun, one of the pagan tribes of the Malay Peninsula, Skeat and Blagden [20] remark: "This framework is the same as that constructed by the Mantra and Besisi; as well as by the Malays, who call it *kulang dapor* or 'hearth frame.' It may be a survival of hut- or hearth-burial." The Batak grave has probably retained the primitive form more perfectly than the Malay, since the hearth is a special inclosure, with its own framework, on top of the larger mound, the whole surface of which appears to represent a hearth in the Malay grave. As will appear later, the Malay grave has been somewhat modified from its primitive form by the adoption of two grave-posts of Arabic form, which have been substituted for the single post of the earlier Indonesian grave, but the retention of the term *dapoer*, 'hearth,' for the top of the grave is clear evidence that the burial customs of the Malay were formerly similar to those of the Batak and other Indonesian pagans. A parallel to the fire which is placed upon the hearth of the Batak grave is afforded in Logan's account [21] of the grave of the Mantra (= Mintira) of Johore. "Above it they kindle a fire, *ungun*, that the *smangat* or spirit of the deceased may warm itself, and not weep and wail in the grave from the cold. On the grave they also place some paddy, plantains, *klédé*, *klèdi*, potatoes, *siri*, betel-nut, gambier, lime, tobacco, a *pisau raut* (knife) made of wood, and a *sumpitan* (blow-pipe) which they have previously broken in pieces,—praying the *smangat* that he will not seek more from them." It is obvious from this quotation that the *dapoer*, not only of

[20] Skeat and Blagden, *Pagan Races of the Malay Peninsula*, Vol. II, p. 114, footnote.

[21] J. R. Logan, *The Superstitions of the Mintira, with Some Additional Remarks on their Customs, &c.*, *Journ. Ind. Arch.*, 1: 307–331. 1847.

the Batak grave, but of Malayan graves generally, was originally an actual fireplace. The mound represents earth, dedicated to the dead. Its surface is a hearth, and represents fire. The apex of the post is a jar, and represents water. In order to complete the representation of the elements, according to the most primitive conception, it is necessary to interpret the lower part of the anisan as food, as the native vaguely does. Although this explanation does very well for the *boewa galoegoer* it is hardly a plausible explanation of the lotus ornamentation, and shows definitely that it was in India and not in Sumatra that the evolution of the Batak grave-post took place. It will be shown that the ornamentation called by the Batak *ipon-ipon*, and said to represent teeth and receptacles for the constituents of *sirih*, and the other carvings supposedly representing foods, are common motives in Hindu and Buddhist architecture. The *ipon-ipon* is the *maha-padma* or lotus throne. From the standpoint of the Batak it is not difficult to see how he might logically enough have come to consider it as a set of teeth. The grave offerings provide the spirit with the necessities of life. The teeth of old people are frequently missing or defective, and the deficiency is supplied by offering actual jaw-bones of animals to the spirit. What could seem more natural, then, than that teeth should likewise be supplied in effigy?

FOREIGN ORIGIN OF THE ANISAN

The anisan must be regarded as having reached the eastern Batak either directly or indirectly from India. The immigrants who introduced it were in a relatively high state of culture as compared with the Batak. After their absorption by the indigenous population, certain elements of the higher culture, such as the symbolic grave-post, persisted, without being entirely understood.

It is a good argument for the external origin of the anisan that its use transgresses the dialectical and social barrier between the distinct populations of Asahan and Tanah Djawa.

The Batak population of Asahan today is a mixed one, but

the oldest recognizable elements are the sub-Toba group who call themselves Pardembanan, i.e., those who call *sirih* by the name *demban.* They speak a slightly differentiated dialect which has not been adequately studied. Later Batak immigrants, direct from Toba or from Mandailing, have likewise settled in Asahan, but the use of the anisan seems to be confined to the old element, the Pardembanan. The *marga* names enable the population of Asahan to be traced to Toba and Mandailing. The Batak of Tanah Djawa have now some admixture with foreign *margas*, but in general the population consists of the four recognized Simeloengoen *margas,* Sinaga, Damanik, Poerba, and Seragih. As far as can be ascertained, the anisan is not found in Toba, the cradle of the Batak, whence most of the Asahan *margas* migrated, nor in any of the Simeloengoen districts except Tanah Djawa, although the same four *marga* names prevail throughout the Simeloengoen country. It must be looked upon, therefore, as an adventive element in both cultures, and its origin must be sought elsewhere.

It has already been stated that there is some regional divergence between the anisan in Asahan and Tanah Djawa. Since such a divergence is no more than would be expected even in adjoining districts after a long period of isolation by war, it can hardly be used to argue the independent introduction of the anisan into the two regions. The first two official Dutch reports of the condition of the border between Simeloengoen and Asahan show that contact between the two populations was unfriendly, in spite of a tradition according to which chiefs of Tanah Djawa entered into a formal matrimonial alliance with certain women of the chiefly families of Asahan, who were called *poeang bolon Asahan.* Controleur A. C. Van den Bor [22] made a trip in October, 1866, from Tandjoeng Bale to the region about Pasir Mandoge on the upper Silo River. He reported that the far side of the river was entirely unpopu-

[22] A. C. Van den Bor, *Bijdragen tot de kennis van Sumatra's Noord-Oostkust, I. Rapport over eene reis van Tandjong Balei naar de omstreken van Pasir Mendagei, bovenlanden van Asahan, Tijdschr. voor Ind. Taal-, Land-, en Volkenkunde,* 17: 377–411. 1869.

lated, on account of the repeated raids of the Simeloengoen people into the Asahan territory. At low water the precaution was always taken to keep guards on watch at night, against possible attacks. In November of the same year Controleur L. De Scheemaker[23] made a trip into the border region from Batoe Bara, reaching a point nearer the coast than that visited by Van den Bor. Here the nearest of the Asahan Batak were those of Silo Maradja. A couple of hours inland from the left bank of the river there lived a certain Batak chief of Tanah Djawa, by name Toean Djahinan, who was known as the chief slave handler in this stretch of country. Whenever the people of Silo Maradja ventured too far into the jungle on the left bank of the Beloeroe River, in search of wild products, he had them seized and sold into slavery. Even today, with slavery a thing of the past, and with constant visiting back and forth between the Batak of the two districts, the stories recounted by the old men of either district are anything but complimentary to the other.

TRADITIONS OF ANCIENT COLONIZATION

In both Asahan and Tanah Djawa there are traditions of ancient foreign colonization which may have been directly from India, or an offshoot from the Hindu colonization of Java and southern Sumatra. An anonymous official publication,[24] based largely upon an earlier account by Kroesen,[25] makes mention of a traditional Hindu-Javanese colony in Tanah Djawa, which would seem to have entered from Asahan by way of the Asahan and Silo rivers. There is a current native legend concerning the gorge known as Batoe Kanihir, a straight-walled canyon through which the Aek Silo flows not far below kampong Ban-

[23] L. De Scheemaker, *Aanteekeningen gehouden op eene reis naar de marktplaats (pedagangan) der Lima Laras, vier dagreizen de rivier van Batoebara opwaarts gelegen*, *Tijdschr. voor Ind. Taal-, Land-, en Volkenkunde*, 17: 412–430. 1869.

[24] Anonymous, *Aanvullings-nota van toelichting betreffende het landschap Asahan*, *Tijdschr. Batav. Genootsch*, 53: aflevering 5–6. 1911.

[25] C. A. Kroesen, *Geschiedenis van Asahan*, *Tijdschr. voor Ind. Land-, Taal-, en Volkenkunde*, 31: 82–139. 1886.

dar Pasir Mandoge. The gorge is said to have been the work of a "Javan" named Si Lopak Ipon, — 'The White-Toothed.' The name is significant, indicating, as it does, a departure from the Batak and Malay custom of filing and blackening the teeth.

In Batak texts it is not exact to translate *djaoe* as Javan. The term appears to have been used in the sense of 'foreign.' Certainly it has applied until recently not only to Javanese but also to Malays. Van der Tuuk [26] has an excellent discussion of the meaning of *djaoe* and of its equivalence to *djawa*. The latter word, as it occurs in the geographic name Tanah Djawa, means 'foreign,' and the name may be translated as 'Land of the Foreigners.'

The legend by which the natives of Tanah Djawa explain the name is given in another official publication.[27] The son of a "Javan" chief, wishing to found a kingdom of his own, went abroad, taking with him from his birthplace a handful of earth and a bottle (made of the *laboe* fruit) of water. First he went to Menangkabau, and from there, accompanied by a Malay, he continued northward. Finally he came to Oerat, a kampong on the south coast of the peninsula of Samosir, in Toba Lake. There he asked the Radja what his *marga* was. "Sinaga Sinoerat," was the answer. "Then that shall be my *marga* also, and we shall be of one family," said the Javan. Thereupon he continued his journey, and after crossing the lake came to Hataran (thenceforth Hataran Djawa) in the kingdom of Si Tonggang, and betook himself to the chief place of the Radja, whereas his companion, the Malay, turned back by himself. At the chief place he strewed the ground with the earth he had brought with him, and sat down upon it, holding the jar of water in his hand. The Radja, having heard of this strange proceeding, went with a great following to the stranger and asked him for what purpose he had come into his land. The foreigner answered, "The ground I sit upon is my ground, and

[26] H. N. Van der Tuuk, *Taalkundige aanteekeningen en bladwijzer, vertaalde stukken, en inhoudsopgave tot de drie stukken van het Bataksche leesboek* (Amsterdam, 1862), p. 43.

[27] Anonymous, *Nota van toelichting betreffende de Simeloengoensche landschappen Siantar, Panei, Tanah Djawa, en Raja.*

this water is my water." The Radja, not understanding the situation, unguardedly said, "If you can prove that, you shall take my place as Radja." The upshot of it was that the stranger became chief, and from that time the land was known as Tanah Djawa.

These myths may be taken as pointing clearly enough to an old immigration of colonists who became the ruling class, to whom later generations ascribed such heroic feats as the cutting of the natural river gorges in hard rock, but who are shown by their adoption into a *marga* to have become assimilated into the bulk of the population. These immigrants were pre-Islamic, for they were makers of images. (The Malay companion of the foreigner in the last story is probably a recent embellishment of the tale.) They appear to have introduced several customs into the country to which they came, notably the use of the grave-post. Exactly who they were, Indians direct from the continent, pre-Islamic Malays of Menangkabau, or Javans, is merely a matter for interesting speculation.[28] We know that

[28] Hunter seems to have given the whole problem of the Hindu colonization of the Indian Archipelago more thought than anyone else. He believed that the colonisation of Java and the neighboring islands was due to descendants of the Ionian adventurers in India, from whose name, Yavana, he derives the name Java. He pointed out that the long voyages from Orissa to Java were strongly in contrast to the land expeditions of Sanskrit literature, which finds it necessary to invent a fabulous bridge in order to convey its armies across the narrow straits to Ceylon. Such long voyages, however, would have been as strictly in accord with the genius of the sea-roving Greek as they would have been opposed to the instincts of the home-loving Hindu, whose religion forbids the higher castes to cross the sea. Hunter says: "The Yavana colonization of the Indian Archipelago probably started from Tamluk (Orissa), in the first century A. D., and the Asoka pillar alluded to by the Chinese pilgrim [Hiouen Thsang, 626–645 A. D.] attests its [Tamluk's] existence in the third century B. C. Even at this day, the ancient Buddhist port of Orissa bears traces of its origin. In 1781 an English official reported a local tradition to Government that Tamluk was originally a Buddhist town, and a large emporium of eastern trade, and had many fine monasteries. It is said that there are still some Hindus there who bury their dead after the Buddhist (and Yavana) fashion." (W. W. Hunter, *Orissa*, 2 Vols., London, 1872. Quotations from Vol. I, p. 310.) The clue in the last sentence would be an interesting one to follow up, even after the lapse of nearly a century and a half, for it indicates a possibility of finding in India itself something analogous to the Batak grave.

they had a Hindu culture of an ancient or at least of a primitive type.

THE MUSLIM NISAN

In spite of the obviously Hindu origin of the Batak anisan, it bears a name which would indicate at first sight that it is the same as the grave-post of the Malays and other Muslims of the East, namely, the nisan, which is used all the way from Constantinople to Hongkong. It will therefore be necessary, before discussing the Indic analogies of the Batak grave-post, to deal with the Muslim nisan sufficiently to show that it is structurally different from the anisan, even though the name is the same.

In the Indonesian languages some variant of the word nisan is very generally used by the Muslims to indicate a grave mark. It occurs in Malay as *nisan*, *nisjan*, or *nesjan*, in Javanese as *nisan*, *mesan*, or *medjan*, in Mandailing Batak (among Muslims) as *medjan*, in Gajo as *indjön*,[29] and even among so rude a people as the Sakai of Siak as *nesang*.[30] There can be no doubt that its extension has been brought about by Malay-speaking Muslims, whose nisan is a grave mark of a form introduced into Indonesia from Arabia or Persia.

A Malay form of the word nisan is so familiar to all whom the Malay version of the Bible was designed to reach, that it was used by Klinkert[31] in his translation of the Scriptures. Thus, in Genesis 35, 20, "And Jacob set a pillar upon her grave: that is the pillar of Rachel's grave unto this day," pillar is rendered as nisjan. The Bible in Toba Batak (Johannsen's version[32]), however, does not use nisan for the reason that it would have been unintelligible to the pagan Batak of the highlands, whose contact with Islam has been slight.

[29] C. Snouck Hurgronje, *Het Gajoland en zijne bewoners* (Batavia, 1903), p. 313.

[30] M. Moszkowski, *Die Völkerschaften von Ost- und Zentralsumatra*, *Zeitschr. f. Ethnologie*, 40: 634–655. 1908.

[31] *Kitaboe 'Lkoedoes, ija-itoe segala Kitab Wasiat Yang Lama dan Wasiat Yang Beharoe, tersalin kapada behasa Melajoe.* Amsterdam, 1909.

[32] *Padan na Robi, hinabatakon ni P. Johannsen.* Elberfeld, 1894.

Neither is it included in Warneck's Toba Dictionary,[33] except in the form *medjan*, doubtless borrowed from Mandailing, and misapplied to the *gale-gale*, a puppet with movable limbs which plays an important rôle in the pagan funeral ceremonies. Among the pagan Batak the word appears to have been anciently adopted only in Asahan and Tanah Djawa, in the form anisan, and among the southern Batak of the Bila and Pane basins in the form nesan. In the latter case the nesan is merely a cubical stone, according to Neumann,[34] and not the conventional Muslim grave mark, thus affording an example of the adoption of a foreign word without the thing to which it applies. The Gajo people, neighbors of the Karo Batak, have long since been converted to Islam, and they use their form of the word nisan, *indjön*, for the Ricinus plants (*gloah*) or dead *gloeni* branches placed at the head and foot of a new grave as temporary substitutes for gravestones.[35] In such cases it seems almost as if the word were felt to have its primitive Arabic significance, sign or token, rather than to apply only to the conventional Islamic grave mark.

In Turkey the headstone of a man's grave is a cylinder or straight-sided prismatic pillar surmounted by a round object, whereas that of a woman is an upright flat tablet ornamented with plant motives of some sort. Van Lennep[36] described the Turkish graves as marked by "one, and often two, upright stones. . . . The larger, upright stone, set up at the head of the grave, is surmounted by an imitation of the headdress worn by the dead, and contains the inscription. Many of the extensive cemeteries at Constantinople contain an extremely varied and highly curious museum of the headdresses worn by the Turks ever since the conquest, i.e., for the last four hundred years; and in the interior of the Peninsula, particularly at Broosa, the first seat of the Turkish empire, specimens are found of a

[33] J. Warneck, *Tobabataksch-Deutsches Wörterbuch.* Batavia, 1906.

[34] J. B. Neumann, *Het Pane- en Bila-stroomgebied. Derde afdeeling, derde boek*, p. 501.

[35] G. A. J. Hazeu, *Gajosch-Nederlandsch Woordenboek.* Batavia, 1907.

[36] Henry J. Van Lennep, *Travels in Little-known Parts of Asia Minor*, (London, 1870), p. 289.

still higher antiquity. This custom does not appear to have prevailed among the Saracens, but seems to be confined to the Osmanly race. . . . The graves of the women are marked by an upright slab, pointed at the top, often carved and gilded; the smaller stone at the foot usually bears the carving of a cypress tree, which is the Turkish emblem of a graceful woman. The custom of planting a cypress tree at the head of each grave is certainly beautiful, but the Christians are not allowed the privilege."

A series of beautiful plates of dated Muslim gravestones at Pergamon has been published by Van Berchem.[37] Those of which the inscription indicates the sex of the deceased show dates ranging from 1482 to 1830. During this long period Turkish graves were marked by both headstones and footstones. The latter are, for both men and women's graves, flat slabs, with the apex generally narrowed in the form of the pointed Muslim arch, with the inscription on the front and often with a bas-relief on the back of a hanging lamp between two candles. The headstone of the woman's grave is of the same form as the footstone, bearing, in addition to an inscription, a mosque, minaret, and cypress tree, in bas-relief, or designs made up of leaves and flowers. The headstone of a man's grave is generally a straight-sided pillar, but may be a flat tablet. In either case, however, the top is a representation of the turban, which never occurs on the woman's grave. Of course the graves figured by Van Berchem, chosen because of their legible, dated inscriptions, are those of wealthy persons, and are therefore elaborate ones. The graves of the rank and file in a Turkish city are shown in several plates of a recent portfolio of views of Smyrna.[38] These show the essential difference between grave marks of the two sexes to be that a man's is an upright cylindrical post with a round object at the top, in the case of the graves of the poor not recognizable as the representation of a

[37] Max Van Berchem, *Die Muslimischen Inschriften von Pergamon, Abhandl. k. preuss. Akad. Wiss., Phil-hist. Klasse,* 1911: Abh. VII, pp. 23, Pl. XII.

[38] E. Boissonas, *Pictures of Greece, — Smyrna.* Geneva, 1919.

headdress, whereas a woman's is a flat slab or board pointed at the top.

Muslim grave monuments in India appear to be of various types. In the vicinity of Delhi, at least, the usual types are described by an inquiring observer as follows: "The monuments of men are recognizable by a segment of a cylinder called a *qualamdan*, 'pen-box,' raised on the flat upper surface, and those of women by a flat surface in shape like the wooden boards upon which children write."[39]

The literature does not seem to contain very many references to Malayan graves. Skeat[40] says, in his discussion of burial among the Malays of the Peninsula: "One of the relations then takes a piece of any hard wood, and rudely fashions with a knife a temporary grave-post (*nisan* or *nishan*) which is round in the case of a man and flattened in the case of a woman; one of these grave-posts is placed exactly over the head (*rantau kapala*) and the other over the waist (*rantau pinggang*), not at the feet as in the case of Europeans. . . . I may add that in pre-Muhammadan days certain articles are said to have been buried with the corpse, viz., '*b'ras sa-p'riok, asam, garam*' [a pot of rice, acid fruits, salt] together with, in the case of a man, rough wooden models of the deceased's weapons. . . . Tradition says that originally one grave-post (*nisan*) was used, and that the earlier form of a tomb was a circular mound with a single grave-post in the center. It is said that such mounds were formerly used in Sungei Ujong, but I am unable to say if this is so. Sultan Zeinal 'Abidin of Johor is also described as having a tomb of this description at Kota Tinggi. . . . To the knob of the grave-post is tied a strip of white cloth as a sign of recent death. . . . The woman's *nisan*, as has been explained, is distinguished by its shape. The temporary *nisan* may be replaced by a permanent one at any time after the funeral. . . . From observing a good many of these grave-posts in different localities, I should be inclined to suppose that

[39] J. D. Tremlett, *Musalmans' Tombs, Panjab Notes and Queries*, 1: 38. 1884.

[40] W. W. Skeat, *Malay Magic* (London, 1900), pp. 405–408.

the grave-post used for men had been evolved from a phallic emblem, whilst that used for women occasionally assumes a rude resemblance to a human being."

In order to attest the general use of the nisan, as described by Skeat, among Malayan Muslims, it will suffice to cite a few distant localities where the grave monuments are alike. Snouck Hurgronje[41] has published photographs of graves in Atjeh, which satisfactorily cover the point for northernmost Sumatra. The writer of this article took photographs in Asahan, some of which are reproduced in Plates XXII and XXIII, which show the Malayan nisan much more clearly than any that have been published. The Malay cemetery at Singapore was also visited, and similar graves were seen and photographed there. Whitehead[42] has published a sketch of a Sulu graveyard in Palawan. He says: "The graves are raised about a foot from the ground, the sides being built up with rough timber. The curious round, bottle-like head-pieces are made of wood and are used for men only, and are probably a modification of the Turkish turban head-stakes, — the head-pieces for the women's graves being flat." Finally, at Hong Kong, a cosmopolitan seaport, there have been many Malay and Javanese burials in the Muslim cemetery. The graves, for both men and women,

[41] C. Snouck Hurgronje, *The Achenese.* (Translated by A. W. S. O'Sullivan.) Leyden, 1906. The illustration of graves is in Vol. I, p. 59. The description (Vol. II, p. 431) is as follows: "The tombstones were given a different shape, according as they were intended for men or for women (*nisan agam* and *inong*). Those for men, for instance, were prisms with four, six, or eight angles. Sometimes, too, they narrowed to the base, so that the lower surface was smaller than the upper, while the side surfaces resembled reversed trapezia. Foot-pieces and ornamental tops of various forms relieved the unwieldiness of their appearance, and the whole surface was cut in fine patterns of leaf work, the words of the confession of faith sometimes engraved on the stone. For women, the side surfaces of the stones were made narrow, the back and front broad; as the Achenese express it, the stones are flat or thin. On both sides, where the crown joined the trunk, were widely projecting spiral ornaments suggesting ears, and called *subang* (ear-rings) by the Achenese. Sometimes the two stones were connected by a long flat one which overspreads the whole surface of the tomb from head to foot. This is called *batèë badan* (body stone)."

[42] John Whitehead, *Exploration of Mount Kina Balu, North Borneo* (London, 1893), p. 317.

are quite like those in Asahan, and some of the more interesting ones are shown in Plates XXIV and XXV. It was possible to identify these graves as Malayan through the kindness of a Malay whom I met at the mosque, and who took me to the cemetery, and there introduced me to an elderly Javan whose daughter had just recently been buried. The Chinese Muslims use the same cemetery, but do not use the nisan. Their graves more closely resemble those of Christians. My Malay friend pointed out a unique stone near the wall in the old part of the cemetery which he said was a nisan, but that it had been moved from a field in the valley by the cemetery authorities and therefore no longer marked a grave. (Plate XXV, Fig. 2.)

From the photographs and descriptions it will appear that the Muslim nisan of the Near East differs from that of the Malayan region only in slight details, which have no obvious significance. Whereas in the western part of its area the male form is straight-sided below the round object at the apex, in the eastern part it is more often bottle- or urn-shaped, with various zonal flanges and constrictions which seem to vary according to the fancy of the stone-cutter. In the West the flat, female form generally has the simple outline of a pointed arch, with the cypress or other plant motives in bas-relief. The only variation in Malaya is that there is a tendency to scallop the sides of the tablet to accommodate the outline to the plant design used. Throughout the entire range of the Muslim nisan there is the same essential difference between the forms used on the graves of men and women, the one being either a straight or modified pillar, with a round object at the apex, the other a flat tablet with a pointed apex.[43] There is also this essential uniformity in the Muslim graves, that there are two grave-stones or posts. The flat, horizontal body stone may be used or not.

On account of the dearth of easily accessible material regarding Muslim grave marks, they have perhaps received here an amount of attention out of proportion to their bearing upon the problem of the Batak grave. It has been necessary, how-

[43] See Excursus II, p. 50.

ever, in view of the Muslim source of the word anisan, to make it absolutely clear that although the word is probably of relatively recent introduction, the thing to which it applies is pre-Islamic. The differences between the Muslim and Batak grave-posts of the male form are seen to be significant after large series of them have been examined, although there is sometimes a superficial resemblance. The water-bottle at the apex is characteristic of the Batak post; the Muslim post, on the contrary, is terminated by an object which usually represents some sort of a headdress. Lotus ornamentation prevails on the Batak post, as an essential characteristic, but seldom occurs on the Muslim post, and then only through the meaningless whim of the carver. A cloth is tied over the apex of a new post on a Muslim grave, but not on a Batak grave. (The Batak have, however, the possibly analogous custom of hanging a cloth on a line that is stretched diagonally across the grave.) The Muslim grave has two posts, placed over the head and waist (or feet) respectively, whereas the Batak grave has only one post, at the center, or, in case the center of the grave is occupied by an effigy, it has four posts, at the corners. The last two differences apply to the graves of women as well as men. It is on the entire dissimilarity of the female grave-posts, in every respect, that the best argument for the non-Islamic origin of the Batak anisan is based. Aside from the different apex, the female anisan of the Batak is essentially like the male form. The flat tablet of the Muslim woman's grave, in outline a simple pointed arch or a modification determined by the plant motives of the ornamentation, does not resemble it at all.

INDIC ANALOGIES OF THE BATAK GRAVE

The writer believes that the Batak grave of Asahan and Tanah Djawa was introduced into Sumatra by Indic peoples whose culture was old enough, or at any rate primitive enough to retain the type of grave which various students have supposed to have evolved into the Hindu temple. Evidence from India itself is not abundant that such a structure ever existed,

but, meager as it is, it takes on new significance in the light of the evidence afforded by the Batak grave. It is easy to understand that in India the early stages in such a developmental series as that from grave to temple may well be lost, since early Indic architecture utilized wood in construction, instead of stone, which is now always used, and since earth burial has been largely supplanted by cremation and the commitment of ashes to sacred streams. Only among the primitive tribes of India, whose customs are still uncontaminated by Hinduism, or among peoples at the very outskirts of Hindu influence, as for example the Batak, would one expect to find preserved the early stages of the evolutionary sequence.

There is excellent evidence that cremation has become established in India in relatively recent times, — since the last Aryan invasion. On this point Crooke[44] says: "Excavation shows that in South India at least, inhumation was the practice of the earliest races. . . . In early Aryan times both inhumation and cremation prevailed. . . . Before the separation it seems probable that the Aryans exposed their dead. Later on, under Brahman influence, it became the rule to cremate the corpse and bury the ashes in or near the spot occupied by the pyre. This, again, was modified into the present custom of cremating the corpse and consigning the ashes to a sacred stream. . . . When the Hindus abandoned the custom of earth burial, they still retained traces of the more primitive method. They prescribed burial for the bodies of persons dying in a state of taboo, like ascetics, lepers, women dying in child-birth, and young children. These last are in North India very generally buried under the threshold, possibly with the hope that they may be reincarnated in the family. So the primitive rite of providing a funeral feast, at which in its earliest form the corpse was consumed by the survivors by way of a sacrament, was modified into the modern *sraddha*, at which food is presented to the dead and the sainted ancestors of the family."

The prescription of earth burial for the classes mentioned by Crooke is found in the following passage from the Vishnu

[44] Wm. Crooke, *Things Indian* (London, 1906), pp. 127–128.

Purana: "When the deceased is a child, or one who is abroad, or one who has been degraded, or a spiritual preceptor, the period of uncleanliness is but brief, and the ceremonies with fire and water are discretional" (Book III, chap. xiii).[45]

The persisting practice of burying children under the threshold has a parallel among the Batak, who bury the bodies of young children under the house. The Batak of Asahan do so. Von Brenner[46] reported that the Karo Batak also did, giving as the reason that it was to prevent the bodies from being used for medicinal preparations. The *marga* Sembiring of the Karo Batak are supposed to be those, of all the Batak, whose Indic (possibly Dravidian) descent is clearest, and presumably most recent.[47] They are likewise the only Batak who practice cremation, and among them the *goeroes*, or priest-doctors, are not burned, but buried. Here is another striking parallel between Batak and Indic usage, indicating the origin of the Batak customs. To be sure, the native explanation is that the *goeroes* are descended from Toba ancestors, whereas the rest of *marga* Sembiring are not supposed to be, but in such a case one suspects that an explanation has been made to fit customs of which the true origin has been forgotten.

It would hardly be a fair argument to accept Crooke's explanation that earth burial for certain classes is a persistance of primitive usage, without calling attention to the fact that Hindu ritualists adduce other reasons. According to a quotation from the *Madras Mail*, "the sacred *swami's* of the famous temple of Udipi, in the South Kanara District, are not burned but buried, in the sitting posture of a Brahman performing *puja*." An apparently competent commentator offered the following explanation: "It is well known that there are

[45] H. H. Wilson (trans. and ed.), *Vishnu Purana* (London, 1864), Vol. III, p. 152.

[46] Joachim Freiherr von Brenner, *Besuch bei den Kannibalen Sumatras* (*Würzburg*, 1894), p. 235: "Nur Kinder, die noch keine Zähne haben, werden unter dem Hause begraben, damit ihre Leiche nicht zu Arzneibereitungen gestohlen werde."

[47] H. Kern, *Dravidische volksnamen op Sumatra*, in his *Verspreide Geschriften*, Vol. III, pp. 67–72 (Leiden, 1915).

four orders in the twice-born castes. . . . The Sannyasins are called Swamis, i.e., lords. . . . After death their bodies are buried. . . . because the Sannyasins are forbidden to touch the fire. . . . At the time of his admission into the fourth order, the twice-born man performs the *viraja homa* ceremony, by which he gives up his right to partake in, or perform, any ceremony connected with the three lower orders. Now a child of the twice-born is, according to law, initiated and admitted into its paternal caste after teething, and thenceforward comes under the control of the sacred domestic fire: so if an infant die before teething it is buried and not cremated. After initiation, all the three lower orders must perform their religious duties and ceremonies in or under the auspices of the domestic fire (*grihyagni*) and they are cremated as being under that fire. But a Sannyasin, after the *viraja homa*, gives up his connection alike with the three orders, the domestic fire, and the world. Here are a few of the precepts to be followed by the Sannyasin, as stated in the laws of Manu, Chap. VI: 'Departing from his house, taking with him pure implements (i.e., his waterpot and staff), keeping silence, unallured by desire of the objects near him, let him enter into the fourth order. . . . Let him have no culinary fire, nor domicile. . . . An earthen waterpot, the roots of large trees (i.e., the shade of trees as his only shelter), coarse vesture, total solitude, equanimity towards all creatures, these are the characteristics of a Brahman set free.'"[48]

The most logical explanation of the prescription of earth burial for priests would seem to be that the extension of the Brahmanical system among the South Indian population was attained by making concessions to the priests of the old tribes, who took over the new religion, but retained for themselves old usages, which later became enveloped in puranic lore. This explanation, of course, denies the Aryan descent, or the exclusive Aryan descent, of the South Indian Brahmans, but nothing is more generally accepted in Indian anthropology than that the Brahmans are largely Dravidian in blood in Dravidian

[48] R. D. M —, *Madras Swamis, Indian Notes and Queries*, 4: 159–160. 1887.

districts, differing little, if at all, from the bulk of the population.[49] The Hindu religious system took over as much, probably, from the aboriginal tribes as it did from the Vedic system. It is necessary to mention only a few points to make this clear, — the adoption of phallic worship, mentioned with abhorrence in the Vedas; the whole Siva cult, taken from the Dravidians; the veneration of idols; and, finally, the use of temples. Architecture in early India was a Dravidian and not an Aryan art. It is difficult to believe that Hinduism could have amalgamated as thoroughly as it did with aboriginal religion without taking over the aboriginal priesthood. On the fringe of Aryan infiltration, where the Aryan blood was already greatly diluted by mixture with the Dravidians, Brahmanical sanction would be granted for old practices which the aboriginal priesthood clung to tenaciously. We may believe earth burial to have been such a practice.

If the supposition is true, that burial was the early Dravidian method of disposing of the dead, we should expect it to persist among aboriginal tribes not yet won over to Hinduism. Crooke states that many of the jungle tribes retain the custom, although others practice cremation. It will be impossible to review the burial customs of the Dravidian tribes *in extenso*, but one tribe must be particularly mentioned because of the light that it throws upon the hypothesis proposed in the last paragraph. The aboriginal priests of the Coorgs, although not recognized as equal in standing to the true Brahmans, have at some period been invested with the Brahmanical cord. "Burying the dead is customary among the Coorgs. Ordinary people are buried on the village burial ground, and children in some reserved place near the house. Men of importance have a tomb built over their graves with a masonry bull, the emblem of Siva, surmounting it. . . . The Coorg Rajahs are buried in a sitting posture and surrounded with a mixture of salt, sacred ashes, and sulphur. The late Assistant Commissioner, Rai Bahadur Ch. Soobiah, was the first Coorg, who, two years ago

[49] Hunter, *Orissa*, I, pp. 241–265, has a careful and well considered discussion of the ethnic complexity of the Brahman caste.

1885 was buried in a coffin. . . ." The Amma Coorgs form a small and exclusive sect who are said to represent the indigenous priesthood. "It may be conjectured that the Brahmans, coming in contact with the rude Coorg mountaineers, and seeing in the dominant race a promising field to further their own interests, imposed upon them their own puranic superstition and peopled the high mountains with celebrated *rishis* or hermits, chief among them Agastia Muni, and brought the source of the Kaveri in relationship with the principal Brahmanical deities, Siva and Parvati, and to give divine authority to their proceedings they foisted upon the Coorgs the Kaveri Purana, a feat which may have overawed a rude and superstitious race, but which by modern criticism is discovered as a fraudulent imposition of recent date. To conciliate and win over the indigenous *bhuta pujaris* [demon priests] they were admitted as a sort of inferior priests of Kaveri Amma [Mother Kaveri], hence their name, Amma Kodagas. In the course of time disputes must have arisen between them and the more crafty and learned Brahmanical priests whose interests necessitated a monopoly, and, as legend has it, the former fell under Kaveri's curse, and decreased, whilst the Coorgs who sided with Agastia Muni were promised increased prosperity. But however obscure the history of the Amma Coorgs may be, the fact is that from time immemorial they perform no priestly functions whatever, and being unlettered and ignorant they exercise no spiritual influence upon the rest of the Coorgs, from whom they are only distinguished by wearing the Brahmanical cord and abstaining from animal food and fermented liquor."[50]

If it be granted that the evidence is good that earth burial was widely prevalent in aboriginal India, it may next be asked if there persists in India itself any vestige of such a structure as the Batak grave-post, which we have assumed to have been introduced from India into Sumatra.

When it is borne in mind that the Batak grave is a shrine to ancestral spirits, the following account of an analogous

[50] G. Richter, *Ethnographical Compendium on the Castes and Tribes Found in the Province of Coorg* (Bangalore, 1887), pp. 21, 39.

structure among the Santals seems significant. "Outside his house [that of the *manjhi*, village headman] is the *manjhi than*, where the spirits of his ancestors reside and where all the important meetings of the village are held. It consists of a raised mound of earth and mud, about two feet high and eight feet square, covered by a ragged thatched roof on wooden pillars. The floor is kept carefully swept, like all the courtyards in the village, and in the center stands a small block of wood daubed with red. Attached to the central pillar is an earthen vessel containing water for the spirits to drink."[51] Aside from the fact that the Santals now burn the dead, and that the *manjhi than* is therefore probably a receptacle only for the ashes of the deceased, the similarity to the Batak grave of the square, raised structure, with its central post, is very great. In this respect, that the water-vessel is a real one, and not a carved representation, the Santal structure is a more primitive one than the Batak. It has already been mentioned that to the Batak the water-bottle seems the most essential thing to offer to the spirit. The Santals say: "In the next world it is very difficult to get water to drink. There are frogs who stand on guard, and drive away any who come to the water to drink; and so when Santals die we send drinking vessels with them so that they may be able to run quickly to the water and fill the vessels and get away before they are stopped."[52]

Those familiar with Siva worship will perhaps not be willing to admit anything more than an accidental similarity between the Santal ancestral altar and the Batak grave. It must be admitted that the red-smeared block of wood reminds one of *linga* worship, and that in the *linga puja* a vessel is often suspended so that water trickles from it over the *linga*. The Santals, however, like the other Kolarian tribes, are imperfectly or not at all Hinduized. Their supreme deity is the same as that of the Mundas, Sing Bonga, the beneficent sun god, who is invoked only in serious general calamities, whereas the village

[51] F. B. Bradley-Birt, *Chota Nagpore, a Little-known Province of the Empire* (Ed. 2. London, 1910), p. 118, and Plate opposite.

[52] C. H. Bompas, *Folklore of the Santal Parganas* (London, 1909), p. 410.

gods and the household gods, or ancestral spirits, have to be worshipped on all sorts of occasions.[53] Siva worship is popular among the Hinduized aboriginal tribes of Chota Nagpur, but the native explanation that the water-jar is to provide the ancestral spirits with water points to greater antiquity for the custom of erecting a post with a water-jar on it than the relatively recent spread of Hinduism among these people. It gives us an idea, in fact, of how the worship of the formless *lingas* of South India may have been derived originally from offering water at the grave-posts of ancestors, and also of how easily *linga puja* might be introduced and spread among a people whose sacred places needed no modification to be interpreted as Siva shrines.

A considerable body of evidence is already at hand with regard to the evolution of the grave into the Siva temple, and this evidence, accumulated by Simpson [54], [56] and Sinclair,[55] will now be reviewed.

According to Simpson, the Hindu temple is a cell, square in plan, with a door on one side. It is surmounted in early examples with a *sikhara*, resembling more a tower than a spire, four-sided, with very little curve below but strongly curved above. The outline is what would be produced if the primitive *sikhara* had been constructed by bending to a point four tapering bamboo poles. The theory, of course, is that early construction, of wood and bamboo, was later imitated in masonry, without at first modifying the forms. Crowning the *sikhara* is a member called the *amalaka*, which is circular in plan, and may be likened to a cushion or a compressed melon. On top of the *amalaka* is a *kalasa*, or water-jar, as a pinnacle.

With regard to the development of the temple from a grave, Simpson gives the following evidence. In Jelalabad (Afghan-

[53] Sarat Chandra Roy, *The Mundas and their Country, with an Introduction by E. A. Gait.* Calcutta, 1912.

[54] Wm. Simpson, *Some Suggestions of Origin in Indian Architecture, Journ. Roy. Asiatic Soc.*, N. S., 20: 47–71. 1888.

[55] W. F. Sinclair, *Architecture in India, Journ. Roy. Asiatic Soc.*, N. S., 20: 272–276. 1888.

[56] Wm. Simpson, *Origin of Indian Architecture, Journ. Roy. Asiatic Soc.*, N. S., 20: 545–547. 1888.

istan) he knew of a rude Hindu temple with a *sikhara*, the tomb of a *guru*, whose ashes were in it. This isolated instance could not be used as the basis of a theory, but it reminded him of the tombs of Jogis on the ridge of Delhi, — little round heaps of plastered mud, two or three feet in diameter, similar to those described by Rajendra Lala Mitra in his work on Buddha Gaya. At the latter locality there is a Hindu monastery with a cemetery attached, where about two hundred of the monks are buried. The bodies are buried in a sitting position, and, in the case of mere neophytes, a small circular mound of solid brickwork, from three to four feet high, is all that is deemed necessary for a grave mark.

For men of greater consequence a temple is held essential, and in it, immediately over the corpse, a *lingam* is invariably consecrated. For *mahants* the temple is large and elaborately ornamented. It would seem that even for neophytes a *lingam* was held essential. On the way from Gaya to Buddha Gaya there are several monasteries of Hindu *sannyasis*, and everywhere the graves are alike. In all of these burial structures the temple, if there is one, is identical with the Siva temple. Simpson quotes Rivett-Carnac to show that the burial of monks and the erection of a Mahadeo or *lingam* over their graves is not confined to the district about Buddha Gaya. Rivett-Carnac describes a burial ground attached to a temple in Kumaon, in the Himalayas, where the graves were Mahadeo shrines. "The priest in charge of the temple held that most of the shrines were very old, and accounted for their large number by saying that the yard was the burial place of men of great sanctity, some of whom had been brought from great distances for interment there, and that Mahadeos of an elaborate or poor class were placed over the tombs according to the means of the deceased's friends."

Thus far the Hindu graves, when simple, have been round, and therefore not strictly analogous to the Batak grave. Simpson gives a further example, however, where the parallelism is satisfactory, in the graves of the Jangams, a sect found among the Canarese, the Telugus, and the Tamils. Regarding this

sect, he quotes Newbold as follows: "The tombs of the lingavants of rank are generally massive quadrangular structures, raised on terraces built of stone, and simply but handsomely carved. The interior consists generally of a square chamber, beneath which is a vault containing the real tomb, which is also usually square. Over the head of the corpse is sometimes placed a phallus, often ornamented daily with sweet flowers." The transformation of a grave into a Siva temple in the case of the Jangam sect is particularly important to our theory, because it is a Dravidian sect retaining the primitive custom of earth burial for the whole body, not merely for the bones after cremation, and because the worship of Siva is very generally recognized as of Dravidian and not of Aryan origin.

The transition from a round to a square grave caused Simpson some little difficulty in accounting for the evolution of the temple, but he concluded, with reason, it would seem, that India with its many races and forms of religion would have had many forms of burial. He called attention to a curious passage in the Satapatha Brahmana (quoted in Muir's *Sanskrit Texts*, II, p. 485) which bears upon the subject. It is as follows: "Four-cornered. The Gods and Asuras, both the offspring of Prajapati, contended in the regions [conceived, apparently, as square, or angular]. They, being regionless, were overcome. Hence, the people who are divine construct their graves four-cornered, whilst the Eastern people, who are akin to the Asuras, construct them round. For the Gods drove the Asuras from the Regions."

Here is obviously an attempt to explain by Hindu mythology customs falling quite outside of the scope of the Hindu system, and there is therefore no reason to conclude, with Simpson, that the primitive round grave was Turanian, and gave rise to the stupa, whereas the primitive Aryan grave, shown by Rajendra Lala Mitra,[57] on evidence from the Vedas to have been a mere tumulus, evolved into the square grave and then into the temple. There is no reason why both types of grave

[57] Rajendra Lala Mitra, *Funeral Ceremonies of the Ancient Hindus*, *Journ. Asiat. Soc. Bengal*, 39: 241 ff.

should not have developed independently, and side by side, among both Aryans and non-Aryans. As will be shown presently, the typical stupa has a square base, and is not merely a tumulus, and it therefore ceases to be of great moment to the present argument to decide what race first used either type of grave, since both were eventually used by the Hindus. One would expect the type of grave to depend upon the environment, — the tumulus, heaped up over a body laid upon the ground, to be preferred in stony or swampy districts, and the square type, with an actual excavation, elsewhere.

Sinclair added many observations to those of Simpson, bearing upon the close connection of Hindu temples with tombs, and showing that over a great part of Western India, through the Deccan and Konkan, when an ascetic of unusual sanctity is buried, instead of his being burnt, a small monument is raised over his grave. This monument generally takes the form of a model temple shrine, containing, if the deceased was a Saiva, a *lingam*, and in other cases, more rarely, other sacred emblems. Throughout the same region there are ancient monolithic sepulchral monuments of small size, generally from two and a half to four feet high, on which are sculptures representing the death of the deceased, his judgment before Yama, and his final appearance in heaven, where he worships the *lingam*, or otherwise, according to his creed on earth.

Very commonly these monoliths are in themselves temple models, usually of Dravidian form. Although significant in showing the close connection between temples and tombs, they might possibly appear to mark a retrogressive step in evolution, being mere effigies of the temple which had already developed from the primitive grave shrine. Such a possibility is clearly indicated by the fact that some of the monoliths merely represent a section of a temple. As a result of his observations, Sinclair was "not prepared to draw any positive deduction as to whether the tomb sprang from the temple, or the temple from the tomb; though, looking at the almost universal ancestor worship, in one form or another, the latter appears the more likely hypothesis."

As an alternative to the hypothesis of retrograde evolution, it may be suggested that nothing would be more likely than that the primitive grave shrine would persist through the period of the development of the temple, but that it would be gradually modified to imitate the higher form, thus passing through a series of evolutionary stages explainable only on a basis of the simultaneous existence of the temple itself.

Sinclair[55] called attention to the occasional erection of a Siva temple at the site of a cremation, and therefore not over the body of an ascetic, but of a layman. In a subsequent paper, Simpson[56] was able to cite, on the authority of A. K. Forbes,[58] similar cases from Guzerat. "He who fires the pile collects seven pieces of bone, and enclosing them in a mould commits them to the earth in the place on which the head of the corpse rested. Over the spot the poor raise a simple mound, and place thereon a water vessel and a cake of bread, but wealthy persons erect upon the site of the funeral pile a temple, which is consecrated to Maha Dev (Siva)."

One of Simpson's conclusions, with which we may certainly agree, is that the water vessel mentioned by Forbes "evidently belongs to the primitive forms of burial, and the proper understanding of it would in all probability give us the solution of the *kalasa* which surmounts the *sikhara*. The funereal customs point to the conclusion that it is a water vessel." In all the literature bearing upon the disposal of the dead in India, whether among the aboriginal tribes or the Hindus, and whether by cremation or otherwise, no fact stands out more prominently than that a water vessel has an important part in the ceremonies. Enough examples have been or will be mentioned incidentally in this paper to make the point clear without devoting a special section to it. It has already been stated that the custom of placing a water-jar upon the grave spread into Indonesia from India, and in continental Asia the custom is by no means confined to India.[59]

[58] Alex. K. Forbes, *Ras Mala*, (London, 1878, new ed.), Vol. II, p. 366.
[59] Wm. Simpson, *The* Kalasa, *or Water Pot, in connection with Burial Rites*, *Journ. Roy. Asiatic Soc.*, N. S., 21: 689–690. 1889.

In order to complete the analogy of the Batak grave with the Hindu temple, it will now be necessary to introduce several quotations which not only show the prevalence of the *kalasa* and *amalaka* in temple design, but also bear upon the lotus ornamentation, with regard to which nothing as yet has been said. Havell[60] says: "What the *mihrab* (pointed arch) was to the Musselman, the lotus was to the Buddhist and Hindu. . . . The bell-shaped fruit was the mystic *hiranya-garbha*, the womb of the universe, holding the germs of worlds innumerable, still unborn. The lotus was the seat and footstool of the gods, the symbol of the material universe, and of the heavenly spheres above it. It was the symbol for all Hinduism, as the *mihrab* was for all Islam. . . . Closely connected with the symbolism of the lotus was that of the water pot, the *kalasha* or *kumbhu*, which held the creative element, or the nectar of immortality churned by gods and demons from the cosmic ocean. These two pregnant symbols were employed in Indian architecture and art, both structurally and decoratively, in an infinite variety of ways. . . . Buddhist and Hindu domes, constructively derived from the bamboo also [i.e., just as the *sikhara* was originally of bamboo construction] were made to imitate the bell-shaped lotus fruit and sculptured with the petals of the flower. The combination of the lotus flower, the bell-shaped fruit, and the water pot, form the basis of the designs of most Hindu temple pillars, the prototypes of which were doubtless the carved wooden posts marking the sacrificial area, in the ancient Vedic rites, to which the victims were bound."

These quotations are given primarily for the sake of the statement they provide as to the lotus ornamentation. Needless to say, Havell's theory that the Vedic sacrificial posts were the prototypes of the temple pillars is not easily reconciled with the writer's belief that the temple evolved from the square Dravidian grave. Both ideas will have to be taken into consideration.

With regard to the *sikhara*, Havell gives the following in-

[60] E. B. Havell, *Indian Architecture, its Psychology, Structure, and History from the First Muhammadan Invasion to the Present Day.* London, 1913.

formation, derived from Ram Raz's *Essay on the Architecture of the Hindus*, itself a summary of the Sanskrit technical writings known as the *Silpa-sastras:* "The *sikhara* (main portion of the dome of a Dravidian temple *vimana*) is surmounted by the *stupi* or pinnacle, which has two principal members, the *maha-padma*, or great eight-petalled lotus, joined to the *sikhara* by a moulding called the *pattica;* and the *kumbha* or *kalasha*, the symbolic water-pot. . . . The divisions between the petals [of the *maha-padma*] marked the four cardinal and intermediate points."

Bearing in mind that the author we are quoting expresses himself somewhat mystically, as an interpreter of Hinduism is privileged to do, we may borrow a few more sentences which deal with the *amalaka*, the last feature of temple ornamentation or symbolism that need concern us. "The cap at the crown of the dome — decorated by the *maha-padma*, the mystic eight-petalled lotus, or by the *amalaka* — resembled the nave of a wheel, the most sacred of all symbols, as denoting the central force of the universe, the Cause of all existence. Hence the prominence which was given to this member by all Indian craftsmen, and the veneration with which the *amalaka* was regarded. The water pot or *kalasha*, containing a lotus bud, placed above the *maha-padma* or the *amalaka* as a finial was a most appropriate symbol of the creative element and of life itself."

The analogies of the Batak grave with the Hindu temple will be so obvious to the reader as to require hardly more than a summary. The water-jar, *taboe*, at the apex of the male anisan is of course the *kalasa* of the temple. The round object below the water-jar, called *boewa galoegoer* (the fruit of *Garcinia atroviridis*), corresponds to the *amalaka* of the temple. There has been much discussion of what the *amalaka* really represents in India, and some authors, as Sinclair,[61] for instance, have seen in it nothing more than a representation of the annular

[61] W. F. Sinclair, *The* Kalasa, *or Water Pot, in Indian Architecture, Journ. Roy. Asiat. Soc.*, N. S., 21: 690–692. 1889. "I have been looking over the plates in Fergusson's Indian Architecture, to see what could be made out of them about the *amalaka* ornament on temple spires. There is a pretty good sequence in respect of pillars. In the early caves an inverted bell-

pad which is worn on the head when carrying a round-bottomed water-jar. Simpson seemed inclined to accept Fergusson's theory that it either was, or simulated, a relic casket. This theory carries the implication that the structure developed after the abandonment of earth burial for cremation, and although it has a certain support, from analogy with the relic holder of the elemental stupa, it quite disregards the prevailing Hindu tradition that the *amalaka* represents the fruit of the emblic *myrobalan.* Sinclair quotes Fergusson to the effect that "the fruit of *Phyllanthus emblica* is too insignificant a berry to be looked upon as the origin of an important architectural form. Moreover, when fresh, it has not the least resemblance to the *amalaka* of a temple, and though it is a little more like one in shape when dried, the comparison is still a strained one." Other names for the *amalaka* are given by Rajendra Lala Mitra,[62] viz., "*amra* or *amrasila,* so-called from its resemblance to the emblic myrobalan. In the Agni Purana, and in the Manasara, it is named *udumbara,* and likened to the fruit of the *Ficus glomerata.*" Tradition insists that the *amalaka* represents a fruit, and there is no reason which seems sufficient to

shaped water-pot is a common capital (Fergusson's "Persepolitan" capital) and one of very similar shape is still used in the cave region to cap the 'kambs' (*stambha*) erected near many villages for festival purposes — 'Maypoles' one might call them. Where anything has to be superimposed on a round-bottomed inverted pot, the annular pad is as necessary between them as it is under the pot when right side up. . . . This capital dies out as we get to the later caves, and is replaced by a pot right side up. . . . Under this there is always a circular member, which appears to me to be the same pad in its right place. . . . As we get on in the caves, and into the early structural temples, the pad has in some cases a tendency to disappear, and at last we have, on one side, vases capable of supporting themselves. . . . On the other side, however, the pad supersedes the pot, and becomes the 'cushion' capital of Elephanta and its generation of caves. I think we have here a clear case of the influence of this annular pad upon temple designs, including pots. And as in the temple spires we have undoubtedly the pot (which goes to this day by that very name '*kalas*'), the argument from analogy is very strong that the thing next under the pot was originally in the spires (as it clearly was in the pillars) the same thing that is next to the pot on every Hindu woman's head and in every Hindu hut of the India of today."

[62] Rajendra Lala Mitra, *Indo-Aryans,* Vol. I, p. 57. (Quoted by Simpson, *Journ. Roy. Asiat. Soc.,* N. S., 20: 68. 1888.)

the writer of this article for doubting that it does. That some fruit called *amalaka* had ritualistic significance in ancient India is shown by the fact that it was one of the five fruits allowed by the Buddha, as named by the Chinese pilgrim I-tsing.[63] The writer is convinced that some fruit, represented by the architectural *amalaka*, was important in primitive burial ritual, and is one of the elements of the carved grave-post which represents food.

The Batak *anisan* of female form is surmounted by a bowl — or inverted bell-shaped object which may well be a water-vessel modified to represent the fruit of the lotus, the symbol of the *hiranya-garbha*. If so, we have in the male and female forms of the anisan the equivalents, possibly the prototypes, of the two types of early temple pillars, the female post corresponding to the so-called "Persepolitan" capital.

It may seem to be an insuperable objection to the writer's theory of the archaic or primitive nature of the Batak anisan that it should bear the lotus symbolism as well as the easily explicable *kalasa* and *amalaka*. The elaborate lotus symbolism seems to belong to a higher culture than the Hindu colonists brought to the East Coast of Sumatra. At any rate they left to their descendants no idea of its true meaning that was definite enough to persist. Again, it will be necessary to make use of a hypothesis suggested once before, that the grave with its anisan is not merely a degenerate temple, but rather represents a state in the progressive evolution of the grave which developed as a result of imitating the temple, during the time that the temple itself was in course of evolution from the same archaic grave type. This conception will be clearer, perhaps, if we suppose that the development of the temple was from the graves of wealthy and powerful chiefs and priests. During its evolution the primitive square grave, with its central post, would continue to be used by the general population. During the course of

[63] J. Takakusu (Tr.), *A Record of the Buddhist Religion as Practiced in India and the Malay Archipelago* (A.D. 671–695), *by I-tsing*. Oxford, 1896. (On p. 222, the editor points out that I-tsing's list of five fruits, as named in the Japanese edition of the Ekasatakarman, agrees perfectly with that given in the (Pali) *Mahavagga* VI, 6, 1.)

several centuries, perhaps, the post would be modified to embody any new symbolism that might have been embodied in the temple. If, now, earth burial should be supplanted by cremation, and ancestor worship should have had superposed upon it the worship of the gods at the greater shrines, the primitive grave shrine would cease to have a function, and would disappear, whereas the superposed function of the temple would become the chief or only one, and would lead the form of the temple into new evolutionary paths.

The Batak anisan doubtless went to Indonesia with the Hindu civilization which carried Brahmanism and Buddhism to Java, where some of the greatest monuments of Indic architecture in the world were erected. At the time of its introduction into the islands, therefore, the anisan was already a primitive survival in an advanced culture. It persisted because of the failure of Hinduism to take root or to maintain a connection with its source. The absorption of a few immigrants, who taught a few new customs that were passed along, accounts for the anisan.

With regard to the origin of the Buddhist stupa, it is not impossible that the anisan may throw some light. If the supposition is true that the square grave, with its symbolic post, represented an offering of earth, food, fire, and water, we can readily see how the stupa came to symbolize the elements of which the body, according to Buddhist doctrine, consists.

Students of Buddhism and of Indic architecture are in essential agreement that the stupa arose from some type of grave. The symbols of early Saiva architecture are so often the same as those of Buddhist monuments, that there has often been dispute, among Hindu as well as Western authorities, as to whether particular edifices were Saiva or Buddhist. Finally, in their modern forms, both the Siva temple and the Buddhist stupa embody the conception of the five elements making up the material universe, into which the body is resolved at death. It is therefore reasonable to presume that they may have evolved from the same archetype, which was most likely a square grave with a central post.

The stupa is known in various forms, differing somewhat from one another. One form is the *chaitya*. Originally graves, stupas came to be erected to enshrine material relics of Buddha. It is evident from Buddhist writings that such structures were used before the time of the historic Buddha. Buddha gave his disciples directions for his own funeral which show clearly that no new customs came suddenly into existence.[64] Hodgson[65] says that there was never anything exclusive of theism in the connection of tomb and temple, for *chaityas* were always dedicated to the Celestial Buddhas, not only in Nepal, but in the plains of India, as the *chaityas* of Sanchi, of Gaya, and of Bag, demonstrate. The Dhyani Buddhas appear in the oldest monuments of the continent and islands. Finally the Buddhists came to pay adoration to a mere image of the structure devoted to enshrining the relics of their saints. They worship the architectural model or form of the *chaitya*.

Every Nepal *chaitya*, according to Hodgson, is exclusively appropriated to five Dhyani Buddhas, the images of four of whom are placed at the base of the hemisphere facing the cardinal points. The fifth is conceived as formless, and represented in the tumulus itself. To each of these five Celestial Buddhas is assigned one of the five elements of matter, which, according to the perfected Buddhist philosophy, are six in number, just as the Celestial Buddhas are six in number. The five elements symbolized in the *chaitya*, four of them in the images of their respective Buddhas, are air, fire, water, and earth. The fifth is *akasa*, 'ether,' the intact and intangible. More primitive Indic conceptions of the elements are mentioned by various writers, and such a primitive conception I have found

[64] Kern quotes: "Ensuite Ananda demanda de quelle façon les moines devraient traiter le corps du Tathagata. . . . 'Ils traiteront,' fut la réponse, 'le corps du Tathagata comme celui d'un souverain du monde. . . .' A cette instruction, le Seigneur ajouta encore: que quatre personnes avaient droit à un tumulus après leur mort: un Tathagata parfait, un Pratyekabuddha; un Disciple du Tathagata; et un souverain du monde." — H. Kern, *Histoire du Buddhisme dans l'Inde* (Paris, 1901), Vol. II, pp. 169 and 229.

[65] B. H. Hodgson, *Essays on the Languages, Literature, and Religion of Nepal and Tibet* (London, 1874), p. 71.

in the Batak grave, which symbolized earth, fire, food, and water. Some such primitive conception as the latter must have preceded philosophical Buddhism. The symbolism of the stupa may be looked upon as having developed from the offerings to departed ancestors of the elements deemed necessary for existence.

A similar symbolism persists in the *linga* of the Siva temple. According to Natesa,[66] "the several forms of the god Siva in these sacred shrines are considered to be the bodies or casements of the soul whose natural bases are the five elements, earth, water, fire, air, and ether." H. Krishna Sastri[67] states that "a form of Siva combining five bodies in one is known as Panchadehamurti. . . . The *linga* with five faces called Panchamukha-linga . . . has the heads of four Siva images figured on its four sides." The fifth "face" is the usual formless *linga* at the center. The same author states that a *linga* placed at the entrance to an old Siva temple at Raichur (Hyderabad) shows a combination of five *lingas* of the usual type, four at the sides and a fourth, a larger one, at the center. Although aside from the subject of this article, it is interesting to observe that such a *linga* might form a step in a series verifying Havell's explanation of the relatively recent five-domed temples of India.

In view of the analogies between stupa and *linga*, one need not be surprised to find that ancient Buddhist monuments in India have been taken over by Hindus, and revered as *lingas*. Neither is it surprising, if the hypothesis is correct that Siva temple and stupa developed side by side, from the same prototype, to find that in Nepal, which has been said to present in its architecture a picture of medieval India, the finial of the *chaitya* may be a *kalasha*, or water-jar, as in the Siva temple, or that the *chaitya* should be surmounted by a *linga* itself. Hodgson says merely that it "terminates in a *palus* very like a *lingam*." The only figures of Nepalese *chaityas* that I have seen are those in Wright's History,[68] which are rather crude litho-

[66] S. M. Natesa, *Hindu Feasts, Fasts, and Ceremonies*.

[67] H. Krishna Sastri, *South-Indian Images of Gods and Goddesses*. Madras, 1916.

[68] Daniel Wright, *History of Nepal*. Cambridge, 1877.

graphs after drawings, rather than photographs. They seem to show clearly enough, however, the *kalasha*. In one, a very elaborately ornamented finial, consisting of *kalasha* and lotus emblems, rests upon a column bearing four images upon its faces, resting in a lotus blossom. The latter is contained in a basin with a drainage gutter for water. In brief, it corresponds very closely in construction to a five-fold *linga*. Hodgson makes out a very strong case for his belief that the apparent Brahmanical perversions of Buddhism which appear in Nepal are nothing of the sort, but are inherent in Buddhism itself.

There is a type of stupa, the so-called "elemental *stupa*," in which the elements are represented by geometrical forms vertically arranged. To this type belong the *chhorten* of Tibet and Sikhim[69] and the *sotoba* of Japan.[70] The base, a solid rectangular block, represents earth; above it, water is represented by a globe; fire, by a triangular tongue; air, by a crescent; a cone at the top denotes ether. It would hardly be profitable to try to correlate the various parts with the grave. The interesting thing about the elemental stupa is that it has the same symbolism as the relic stupa of ancient India, but presents a vertical arrangement of symbols for the elements, as one would expect if it developed from a symbolic grave mound and post.

It would be easy to be led into further speculation with regard to the possible lines of descent of architectural forms. Perhaps, however, too much has already been said, and the data regarding the Batak grave encumbered by what may be shown to be irrelevant matter. Even if someone should show this to be true, the present discussion would at least have done the service of directing attention to the subject.

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[69] L. A. Waddell, *Lamaism in Sikhim*, in *Gazetteer of Sikhim* (Calcutta, 1874), pp. 241–391.

[70] James Troup, *On the Japanese Sotoba, or Elemental* Stupa, *Journ. Roy. Asiatic Soc.*, 1919: 557–573.

EXCURSUS I (See page 10)

In the Simeloengoen country northward toward the Karo region the slave who danced with the *topeng* was accompanied by one who carried a peculiar apparatus intended to represent a horse, *koeda*. On this account the funeral play was called *'ngkoedakoedai*. (M. Joustra, *Batakspiegel* [Leiden, 1910], p. 169.) There is an interesting account of the funeral customs of Naga Sariboe, bordering on Karoland, from the pen of Hagen, one of the first white visitors. He found on the wall of the *bale*, assembly house of the men, where visitors are entertained, a short stick wrapped with thread, on the end of which was stuck the dried head of a rhinoceros bird, and pieces of hide cut to represent the ears of a horse. This was a relic of the great play at the funeral of a former radja. On inquiry, the mask, *topeng*, which went with it, was also produced. It had been kept as a valued possession in the house of the radja, since it was originally a present from a neighboring chief. It was neatly carved, and adorned with human hair. It was flecked with dried blood, which the Batak explained as the blood of animals slaughtered for the funeral feast, but which Hagen was so suspicious as to think might have been the blood of the slaves who carried out the *topeng* dance and were probably beheaded to accompany the radja on the other side. In contrast to the custom in Tanah Djawa, the same mask had been used for successive funerals of both men and women, being adorned with ear-rings at the funeral of a woman. It can hardly be doubted that the dance with the horse mask represents a horse sacrifice of earlier times. In Asahan I observed no trace whatever of any custom indicating a former horse sacrifice. On the west side of Toba Lake, however, between the northern Pak-Pak Batak, who border on the Karos, and the Toba Batak who dwell around the southern end of the lake, are the Dairi Batak, among whom a not uncommon type of grave is marked by an almost life-size figure of a man on a horse. Van der Tuuk (*Bataksch-Nederduitsch Woordenboek* [Amsterdam, 1861], Plate XXI, Fig. 3) has an illustration of such a grave, from the pen of Von Rosenberg. He notes that it is more common among the Dairi than among the Toba, and that the image is called *hoda-hoda bakkuwang*. Von Rosenberg figures a similar grave at Lobang Tungkung, in the Dairi district, in his own book (H. von Rosenberg, *Der Malayische Archipel* [Leipzig, 1878], p. 61.) Kruijt (*Het animisme in den Indischen Archipel* [s' Gravenhage, 1906], p. 321) says that the Tobas were accustomed to kill the horses of a dead chief at his funeral, with the idea that they would accompany him to the spirit world for his future use. Among the most southern Batak group, the Mandailing, I have come across only one trace of the *koeda-koeda* or *hoda-hoda*. A Batak grave at Kota Nopan (not

far from Marsipongi) "consisted of a rectangular mound, with a wooden image of a horse's head at one end, and a part of a horse's tail fastened to the other — the mound forming his body. At each of the four corners was an image of a nude man or woman. Over the whole was a rude roof supported on four posts, and around the whole was placed a row of sticks four feet high, and a foot or two apart, bearing on their tops small flags of white cloth." (Albert S. Bickmore, *Travels in the East Indian Archipelago* [New York, 1869], p. 417.) Everywhere there seem to be indications of horse sacrifice except in the region where the anisan is used. It is in the latter region, likewise, that images on graves are cross-legged, seated figures, rather than squatting or standing or astride a horse. These correlations, if they prove to hold good, are probably significant.

Hagen's early account of burial customs at Naga Sariboe is of interest in another connection, as giving evidence that in the northern part of the Simeloengoen country the anisan was not used. At Naga Sariboe the cemetery for common people was a sterile *lalang* hill in the vicinity of the village. Here the bodies were simply buried; the ends of graves here and there were marked only by white flags. The bodies of radjas were buried at a distance from the common cemetery, and singly. After a time the bones were disinterred and preserved in more or less prettily carved little houses, constructed for the purpose. The ossuary of the last deceased radja of Naga Sariboe was located about fifteen minutes' walk from the village, at the place where market was held. During his visit at this kampong, Hagen had a chance to see such a house finished, and dedicated by a banquet on pigs. (B. Hagen, *Rapport über eine im Dezember 1883 unternommene wissenschaftliche Reise an den Toba-See, Tijdsch. Ind. Taal- Land- en Volkenkunde*, 31: 328–382. 1886.) Joustra (*Bataksspiegel*, pp. 168–169) does not seem to be convinced that Hagen's account is concerned exclusively with the Timoer (i.e., Simeloengoen) Batak, since Naga Sariboe is in a district where Karo customs might have been expected to creep in. The ossuaries are like those of the Karo country, and certainly do not extend into the southern Simeloengoen districts.

EXCURSUS II (See page 28.)

It is far from the object of the present paper to delve into the problem of the primitive significance of the Muslim grave marks. Since Skeat's surmise as to the possible phallic origin of the male form has been quoted, it is in order to remark that as far as the Malays are concerned, it has no phallic significance to them, and never did have, for its evolution into the present highly conventionalized object took place before the advent of Islam brought it to Malaya. Skeat's

tentative suggestion as to the female nisan, that it sometimes assumes a rude resemblance to a human being, can only have been based upon observation of the nisan as modified by very ignorant Malays, or by pagans. Skeat and Blagden (*Pagan Races*, Vol. II, pp. 114–115) describe and figure a *nesan* of a Jakun woman's grave in Johor as roughly like a human figure in outline, but of course the modern development of the nisan when borrowed by a pagan group has no bearing upon its early evolution.

There is a highly unscientific and uncritical body of literature in which the view is held that the two forms of the nisan are Saiva emblems, the *linga* and *yoni*. Forlong, especially, has maintained this view, which has some plausibility, but unfortunately his works show such an utter lack of scientific method that one instinctively doubts both his statements of alleged fact and the conclusions he draws from them. (See J. G. R. Forlong, *Rivers of Life, or Sources and Streams of the Faiths of Man,* London, 1883.) It seems to the writer that the male nisan probably developed from a simple post placed on the grave both to mark the place and to serve as an altar to the ancestral spirit. That it might have taken the form of a phallus is not unlikely, but the supposition demands proof. How unsafe it is to see phallic symbolism in every pillar erected by primitive or barbaric man, as Forlong did, is illustrated by the stone pillars of Nias. (Of these there are excellent plates in E. E. W. Gs. Schröder, *Nias, ethnographische, geographische, en historische aanteekening en Studien.* Leiden, 1917.) These are erect stones differing in only one respect from many rude monoliths that Forlong and his school have regarded as phallic, namely, in that there is carved near the base of each a phallus in exactly the position it occupies on other completely carved human images. It is therefore quite clear that the unshaped pillars stand for entire human figures, simplified to the uttermost degree that is consistent with the belief that an ithyphallic figure will put evil spirits to flight. That such a belief is a prevalent one in Indonesia might be shown by many citations, but a few must suffice. Joustra, *Batakspiegel*, p. 173, says that in Padang Lawas the *rapotan*, in which the coffin is borne to the grave, is carved with representations of human genitals, or of a pair *in coitu.* He says that Junghuhn long ago reported the same thing, and that it is an old Batak custom. The quotation from Bickmore on p. 50 has reference to the same usage. Von Rosenberg, *Der Malayische Archipel* (Leipzig, 1878), p. 27, described the outer coffin of a radja in the vicinity of Pertibi as "umgeben mit Holzfiguren, welche zum Teil in unzüchtiger Weise auf den Coitus anspielen, teilweise auch mehr oder weniger fabelhafte Thiere vorstellen." This particular case, from the Batak, is chosen in order to controvert in advance the suggestion that would otherwise surely be made by someone, that the

Batak anisan itself is merely a phallic emblem, with some Indic embellishments. The Batak, like other pagan Indonesians, would certainly not disguise such an emblem, if they wished to use it at all.

Since the female form of the Muslim nisan is nearly always ornamented with plant motives, but the male form never is, in Turkey and the nearer East generally, it seems not unreasonable to try out the hypothesis that it had its origin in the representation of a tree, which would probably be done more easily in bas-relief than in any other way. Among a people migrating from place to place over treeless plains or deserts, it is reasonable to suppose that a primitive custom of marking graves by a tree would have to give way to a substitute. This suggestion of the origin of the female form of the nisan is made with no great conviction of its correctness, but it is certainly favored by the fact that, in the Near East, old graves of men have one stone like that on a woman's, indicating, perhaps, that the primitive grave of a man was marked by a tree and a sacrificial post, and that of a woman by a tree only.

DESCRIPTION OF PLATES

PLATE I

Fig. 1. Complete grave of man, in good condition, at Silo Maradja, Asahan. Note (*a*) the jawbone (*osang-osang*) of the wild hog, suspended from a string passing diagonally across the grave between two poles, (*b*) the water gourd (*taboe*) on the grave, (*c*) the plate (*pinggan*), in this case (exceptionally) a whole one, for offerings of rice, etc. At the center of the mound (*tanoman* or *tano mate*) is the hearth (*dapoer*) whose four points, alternating with the corners of the mound, point to the four cardinal points. The hearth frame is supported at each corner by three notched sticks (*partoenggoel*). The anisan at the center of the grave is described in the text (p. 4).

Fig. 2. The anisan of the same grave as Fig. 1, on a larger scale.

PLATE II

Fig. 1. Male anisan at Haboko, Asahan, the only one remaining in a cemetery found when the jungle was cleared for planting tea. The cemetery contained many graves, of several of which only the vertical palings of the mound remained. Note that the *boewa galoegoer* (equivalent of the *amalaka*) is not separated from the water-bottle, and that the petals of the lotus are more than eight. The number varies, eight being more common than any other. Note also the subsidiary posts at the four corners of the mound.

Fig. 2. Male anisan on the grave of a Batak radja, at Poeloe Mandi, Asahan. The *boewa galoegoer* is lacking. It was from this grave that the ornamental water-bottle on the left in Plate VII, Fig. 2, was obtained.

PLATE III

Fig. 1. Aberrent anisan (male form) at Poeloe Mandi, Asahan. The ornaments are in four's instead of eight's. The post had been stained originally with red ochre, lamp black, and lime.

Fig. 2. A new grave of a man at house of Toean Taratak, near Boentoe Pane, Asahan. The anisan is very aberrent in shape, explained by the natives as due to the fact that no one skilled in such work was available to carve it. It is stained with red, black, and white. Note the man's "worst cloth" (*kain boeroek*) hanging on the line (*pakireon*) over the grave, and the remains of his sleeping mat on the grave. The plate for offerings is broken, as custom requires.

PLATE IV

Graves at Simpang Kawat, formerly Hesa Lama, Asahan.

Fig. 1. A man's grave in the foreground, showing the water-bottle and the equivalent of the *amalaka*. The lotus petals are many more than eight.

In the background, the anisan of a woman's grave, showing the absence of much of the ornamentation of the male anisan, and the bowl-shaped object at the apex.

Fig. 2. One of the most interesting graves seen. (See p. 8). From the galvanized roof of the shelter one may infer that the deceased must have been a chief of some consequence. The water-bottle is surmounted by a bird which is *surmised* to have some connection with the *djinoedjoeng* or guardian spirit. This bird is doubtless comparable in significance to the one shown on the coffin in Plate XXI, Fig. 1. Wooden figures of a gun and a small straight human figure (probably a *pagar*) were lying on the mound. Note the highly simplified woman's anisan in the background.

Plate V

Graves at Poeloe Radja, Asahan. The grave of the locally famous Radja Marlampoe, who resisted Dutch occupation of Asahan, is in this group, but the anisan has decayed. The other graves are those of members of his family.

Plate VI

Fig. 1. The *djirat* or grave house over the grave of a former radja of Silo Maradja, Asahan. It is placed east and west, at right angles to the radja's house. The present radja, Ria Maradja (on the right) and his brother, Dji Maradja, are holding ceremonial spears, ornamented at the middle with long locks of hair, with points downward.

Fig. 2. Grave of the wife of the radja whose grave is shown in Plate VIII. The anisan is of the usual form for a woman, except that it is surmounted by a miniature house, placed east and west.

Plate VII

Fig. 1. Nearer view (from the side) of the djirat shown in Plate VI, Fig. 1. The radja is on the right, his brother at the left, with a little nephew. On the floor of the djirat on a level with their heads may be seen the five tuned drums, beaten at the funeral of the former radja, and, since they are used for no other purpose, left in the djirat.

Fig. 2. Two incised clay water-bottles (*taboe*), the one on the left from the grave of a radja at Poeloe Mandi, the other from the grave of the radja of Silo Maradja, shown in Plate VIII. (Both localities are in Asahan.)

Plate VIII

The grave under the djirat shown in Plates VI and VII. The image is of wood, with mother-of-pearl eyes. The radja is shown with his opium pipe and spittoon. At the four corners of the grave were anisans of the usual male form. (In order to permit this photograph to be taken, Ria Maradja very kindly took out part of the floor of the djirat. The constricted quarters did not allow all the anisans to be shown.)

PLATE IX

Ancient stone grave images at the site of the former kampong Bandar Lama, near Bandar Poeloe, Asahan.

PLATE X

The same images as shown in Plate IX, from different aspects. Note the headdress of the woman, which is different from that of the man. Both are extinct styles, and probably represent the styles of Asahan before Malay or European influence had produced changes.

PLATE XI

Two aspects of a stone grave image at Koeta Boerhoe, Asahan. In the right hand the radja holds his opium pipe; in front of him is his spitting bowl. The headdress is the same as that of the male image at Bandar Lama (Plates IX and X). That the grave images are intended to be portraits is shown by the emaciated figure and prominent collar bones of this old opium smoker.

PLATE XII

Two aspects of a stone image at Koeta Boerhoe, Asahan.

Fig. 1. This aspect shows the spitting bowl and the hilt of the *toemboek lada* or dagger, the latter of a type still found in Asahan as an heirloom (*poesaka*). It also shows the bracelet on the right wrist.

Fig. 2. This shows the water-bottle which the radja holds in his left hand.

PLATE XIII

Ancient stone grave images at Koeta Boerhoe, Asahan. They seem to represent a family consisting of a radja and two children. Any accessories that may have been represented were covered by forest litter.

PLATE XIV

House of the chief of Goenoeng Mĕligas, Tanah Djawa. In the center foreground, at right angles to the house, is a djerat, or grave house, running east and west. Further to the right, near the front of the house, is the *losoeng*, or rice block, made of a horizontal log, where several women can stand on the platform at once and stamp their *padi*.

PLATE XV

Coffin of the former chief of Koeboean, Tanah Djawa, kept in the house. Burial of the Simeloengoen radjas is deferred until the family can accumulate sufficient means for a great funeral festival. In this case it will not take place for several years, until a small son comes of age and succeeds to his father's position (the Controleur and other powers that be permitting!). The coffin, hewn from a log and sealed with damar, has a top shaped like the roof of a Batak house. At the center of the ridge is a

carved stick that serves the spirit as a ladder, to pass to and from his coffin. (This feature is different in the Asahan coffin. Compare Plate XXI, Fig. 1.) In Tanah Djawa the lid of the coffin is not buried at the funeral, but is left on top of the grave (See Plates XVIII and XIX). In Asahan it is buried.

In the foreground of this plate will be seen three of the baskets in which produce is carried from garden to house and to market. They are often very beautifully woven and exceedingly durable. At the right is the chest for family heirlooms, *poesaka*. Hanging at the left is a Malay (not Batak) *saroeng*.

Plate XVI

Combination rice granary and djerat at Radja Mĕligas, Tanah Djawa. There are several graves, some of great antiquity, under this building, some of which are shown in Plates XVII and XVIII. The lower part of the building is a granary, and the djerat proper is perched up on top, being, as in every case observed, at right angles to the great house of the radja. (The roofs are *idjock*, the sightly and resistant fibre which clothes the trunk of the sugar palm.)

Plate XVII

Fig. 1. The most recent grave under the djerat shown in Plate XVI. It departs from the usual Batak usage in that there are two posts. The carving of the anisan is different from that in Asahan, especially in respect to the lower part, which has a diamond design instead of lotus. The lotus, however, still persists at the very base. The equivalent of the *amalaka* (*boewa galoegoer*) is transformed by misplaced lotus carving into a pair of lotus blossoms with petals placed tip to tip. The tendency of the symbolic carving to degenerate into meaningless ornamentation is strong in Tanah Djawa. Note the *topeng*, which is discussed in the explanation of Plate XX.

Fig. 2. A unique stone standing in kampong Pematang Tanah Djawa, Tanah Djawa. It appears to be ancient and has a design somewhat resembling the diamond design which is quite general in the carving of the lower part of the grave-post in this region. The top has been broken. It marks a grave, but its original purpose may not have been to serve as an anisan. Aside from this dubious example no stone anisan of the male form was seen in Tanah Djawa.

Plate XVIII

Graves under the djerat shown in Plate XVI, with ancient stone anisans of the female form, although the graves are said to be those of men. The supposed equivalent of the *hiranya-garbha* (the bowl-shaped object at the apex) is the same in these posts as in the modern ones of the female type in Asahan. The post on the right is in all respects similar, and the one at the left differs only in the presence of the diamond ornamentation which has become so dominant in the modern posts of male form in Tanah Djawa.

Note that on these graves the lid of the coffin is left on top of the ground.

On each grave are two posts, one being of the type with a house at the top, and lacking the usual anisan carving which occurs on the house-posts in Asahan. (Compare Plate VI, Fig. 2.)

Plate XIX

Two aspects of the same graves shown in Plate XVIII from the other end. The house-posts are seen to represent houses of the old Batak type, even the piles on which they stand being indicated.

The pigs root about among the graves under the djerat, displacing the furnishings of the graves, but the natives cannot be persuaded to touch anything with a view to putting it in order unless the *datoe*, 'magician-priest,' is at hand. In the middle foreground of Figure 2 is the central carving from the ridge of one of the coffin covers.

Plate XX

Funeral masks (*topeng's*) from Batak graves.

Fig. 1. A mask from the djerat of a former radja of Pinggan Merdjawa, Asahan. It is of the male form, as indicated by the knob at the top, and the scallops at the hair line on the forehead. The cord with which it is tied is woven of *idjoek*, sugar-palm fibre, although European cord is abundant.

Fig. 2. A male mask from an anisan under a djerat at Kampong Pematang Tanah Djawa, Tanah Djawa. Note the same masculine characteristics as in the mask from Asahan, namely, a knob at the top (wrapped with old red and blue cotton yarn, native-grown and spun) and the three scallops on the forehead.

Fig. 3. A mask from the grave of a woman, at Pematang Tanah Djawa. It represents a woman. The knob at the top is absent, and the line of the forehead is a simple arc.

(The cloth in the background of these three figures was woven in Karoland.)

Plate XXI

Fig. 1. Model of a coffin as used in Asahan. At the time of my visit in Asahan there seemed to be no dead but unburied radja in any of the accessible kampongs. A model coffin was therefore made by Datoe Silotonga and Bidin Sirait Holboeng of Silo Maradja, which is here figured. There is every reason to believe that it is absolutely correct. At the bottom is the *roto*, the bier made of crossed logs, by which it is carried to the grave. The lid is quite as in the Simeloengoen coffin shown in Plate XV, except in accessory details. At the center is a post surmounted by a bird, bearing in its beak and suspended from the tail the ornaments known as *loting-loting*. At the head end of the coffin is an ornament resembling a fern crozier, and at the foot a crescent, resembling, and doubtless representing, a pair of horns.

Fig. 2. Grave of a Simeloengoen woman in Sariboe Lawan, Tanah Djawa. This kampong seems to be beyond the range of the anisan. The graves consist of a simple tumulus marked by a bamboo pole bearing

roedang, a general term for ceremonial plants, in this case an inflorescence of the betel-nut palm.

Plate XXII

The Malayan nisjan.

Fig. 1. Graves of man and wife at Tandjoeng Bale, Asahan. The male nisjan is of the type which is round in cross section. The top is carved as though to represent cloth twisted to a peak. The female nisjans are of the type found on the graves of richer people. Note the profuse ornamentation as compared with the man's nisjan.

Fig. 2. Man's grave at Tandjoeng Bale, Asahan, showing apparently some influence held over from the old Batak anisan. One notes a vague semblance to the water-bottle and *boewa galoegoer* at the apex, but anywhere except in Asahan the stones would seem purely Islamic. The smaller stones appear to resemble water-jars rather closely, but may be the temporary nisjans, left on the grave after placing of the permanent ones. If so, the jar-like shape is perhaps accidental.

Plate XXIII

Graves of poor Malays in the Muslim cemetery at Tandjoeng Bale. The nisjans are of wood, and are here shown in their simplest form. The female type resembles in outline a tree or plant, or a palm frond.

Plate XXIV

Types of the Muslim *nisan* in the cemetery at Hong Kong.

Fig. 1. A recent grave of a man. Note the cloth wrapped about the nisan, according to Muslim custom.

Fig. 2. A less usual type with lotus ornamentation, probably indicating that the carver was accustomed to Indic forms and unconsciously imitated them.

Fig. 3. One nisan of the grave shown in Figure 2, on a larger scale.

Plate XXV

Fig. 1. Woman's grave at Hong Kong, showing the typical nisan as used in Malaya, and the cloth wrapped at the apex, indicating a recent burial.

Fig. 2. Probably an anomalous nisan of male form, near the wall in the cemetery at Hong Kong. It was pointed out by my Muslim guide (a Malay) as a nisan, but bears a striking resemblance to some Christian grave marks which appear to represent an urn draped with a cloth. It is sufficiently curious to attract the attention of anyone interested in such things. What is the origin of our Christian monuments?

PLATE I

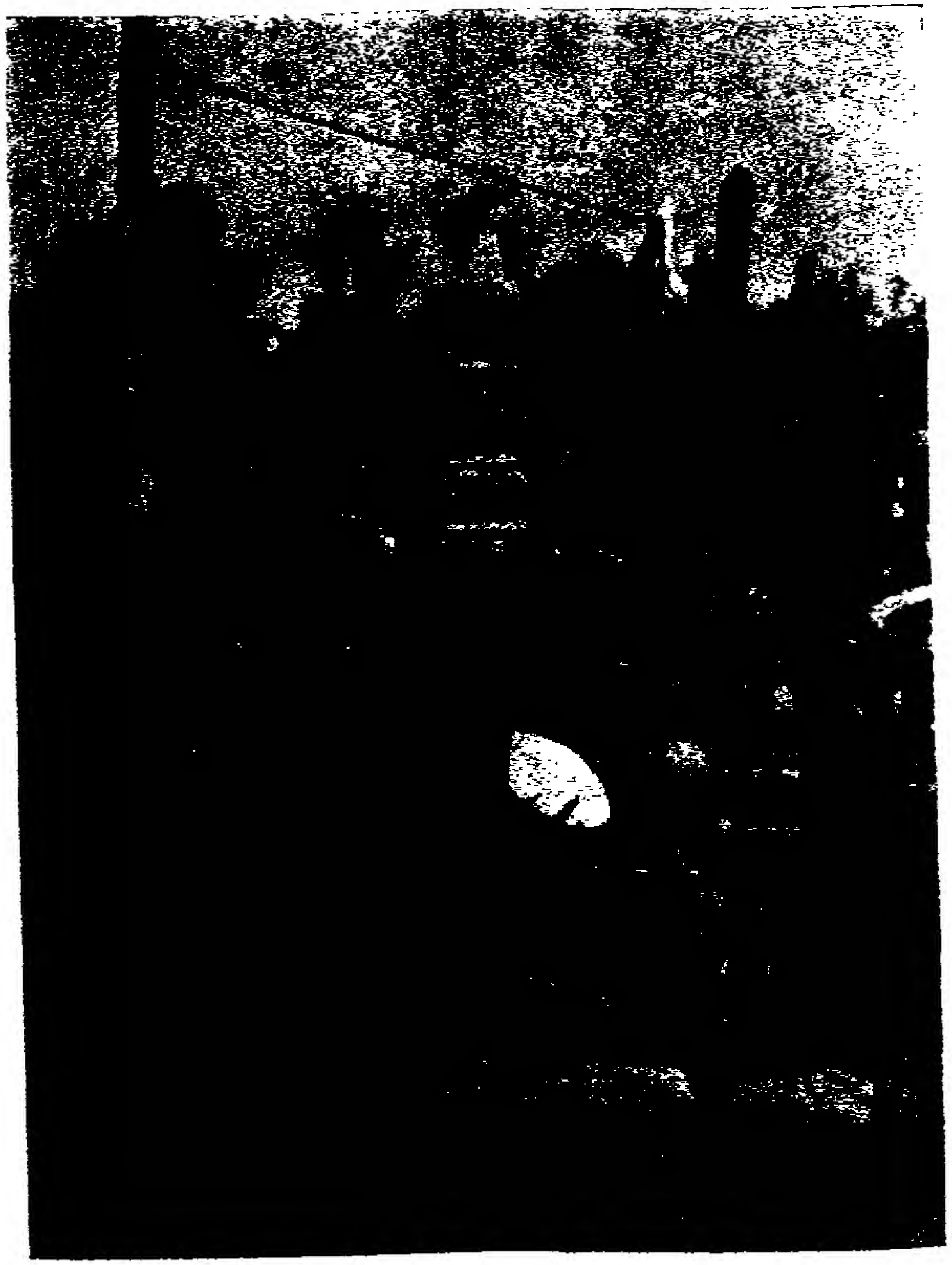

FIG. 1

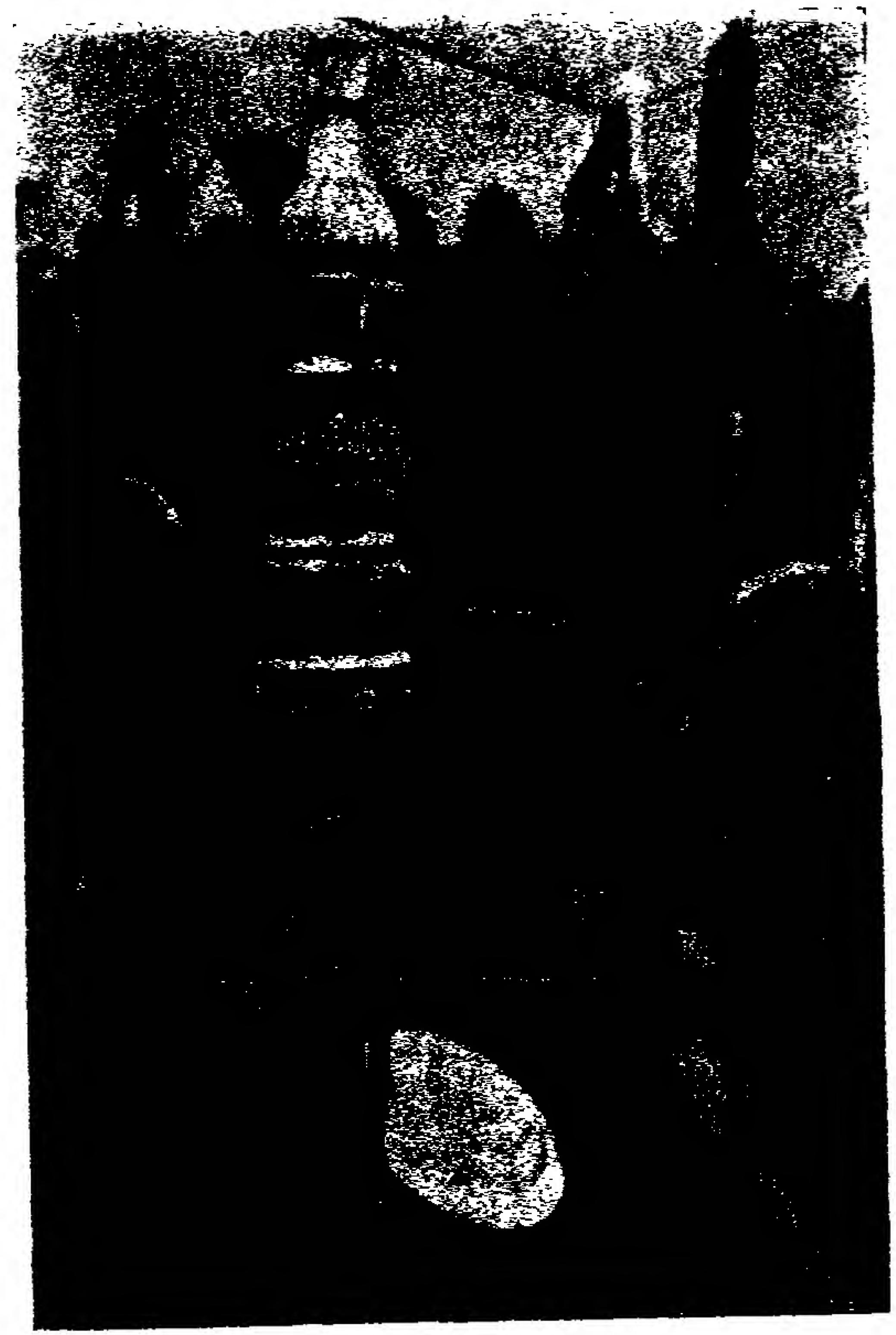

FIG. 2

PLATE II

Fig. 1

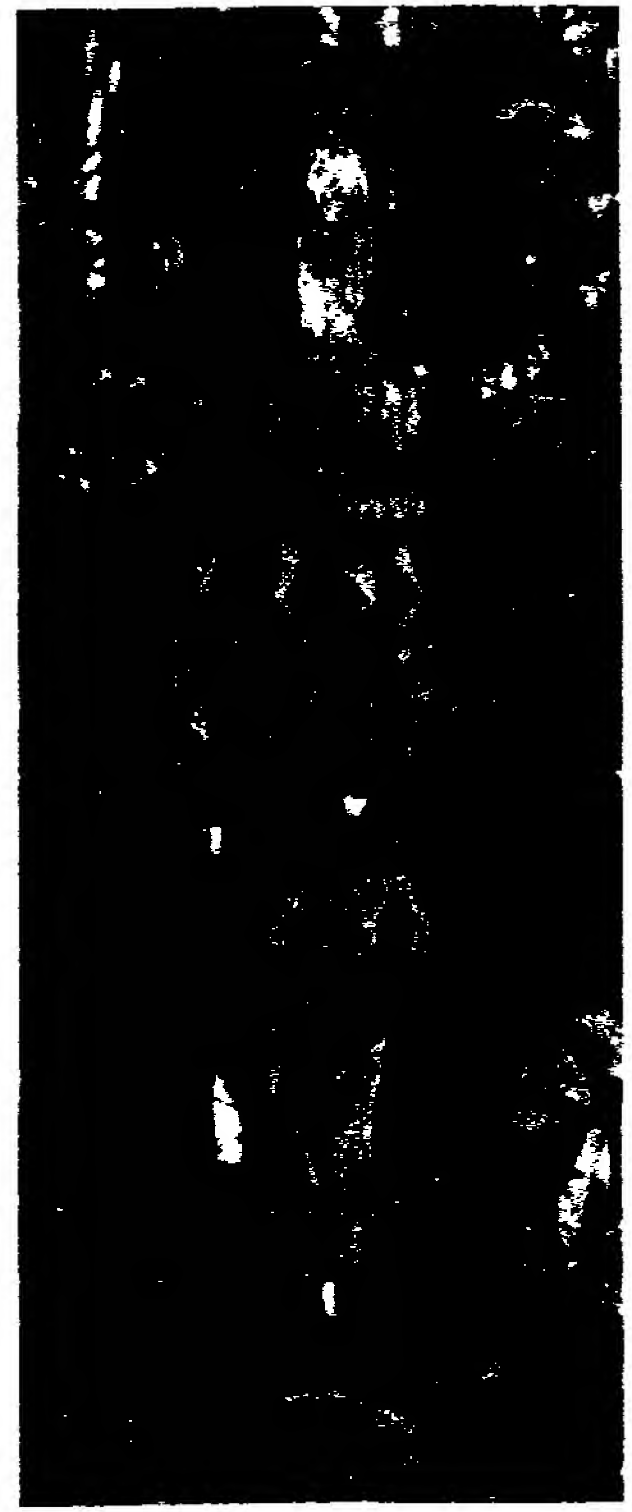

Fig. 2

PLATE III

Fig. 1

Fig. 2

PLATE IV

Fig. 1

Fig. 2

PLATE V

PLATE VI

Fig. 1

Fig. 2

PLATE VII

Fig. 1

Fig. 2

PLATE VIII

PLATE IX

PLATE X

Fig. 1

Fig. 2

PLATE XI

Fig. 1

Fig. 2

PLATE XII

Fig. 1

Fig. 2

PLATE XIII

PLATE XIV

PLATE XV

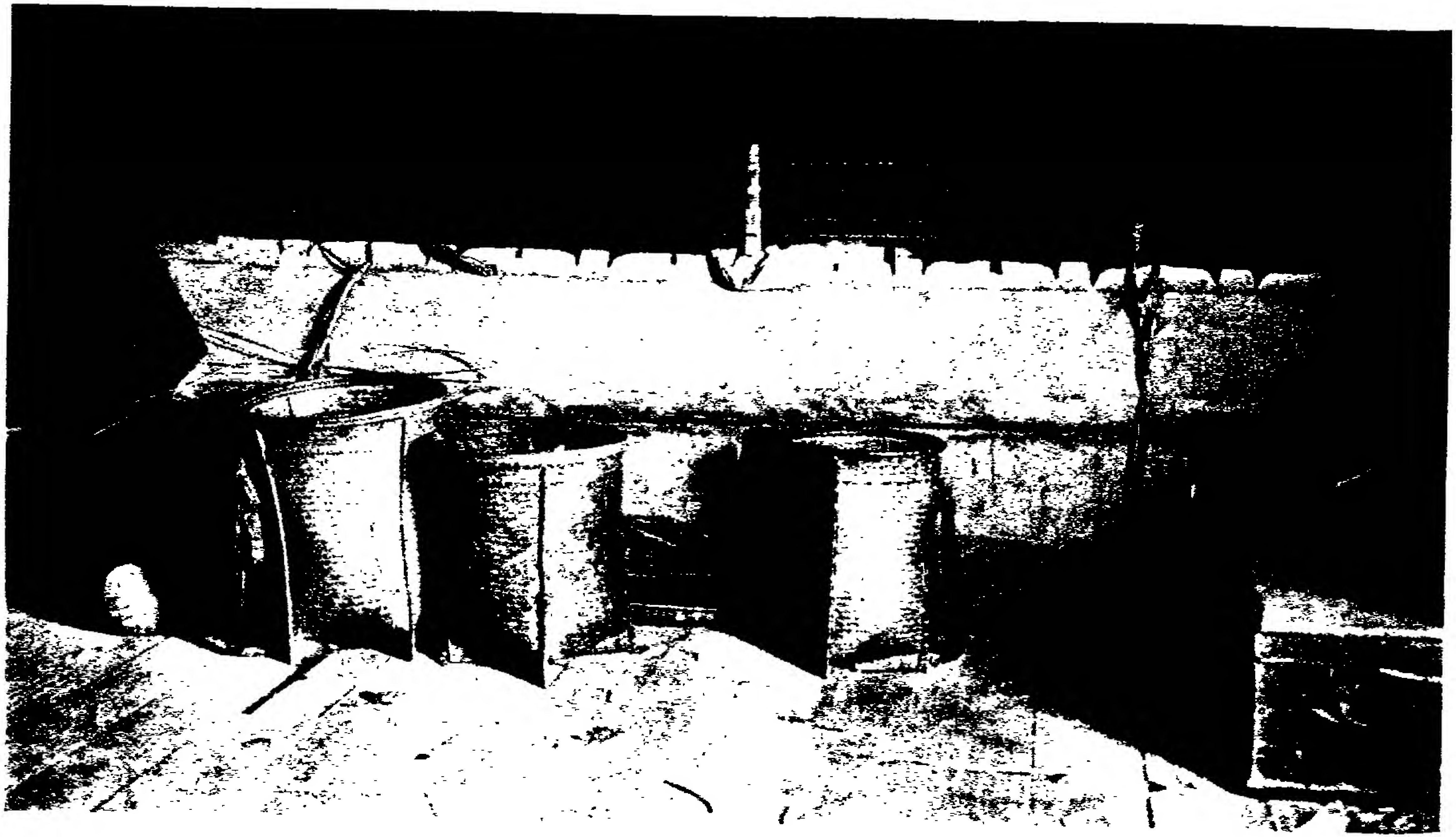

PLATE XVI

PLATE XVII

Fig. 1

Fig. 2

PLATE XVIII

PLATE XIX

FIG. 1

FIG. 2

PLATE XX

Fig. 1

Fig. 2

Fig. 3

PLATE XXI

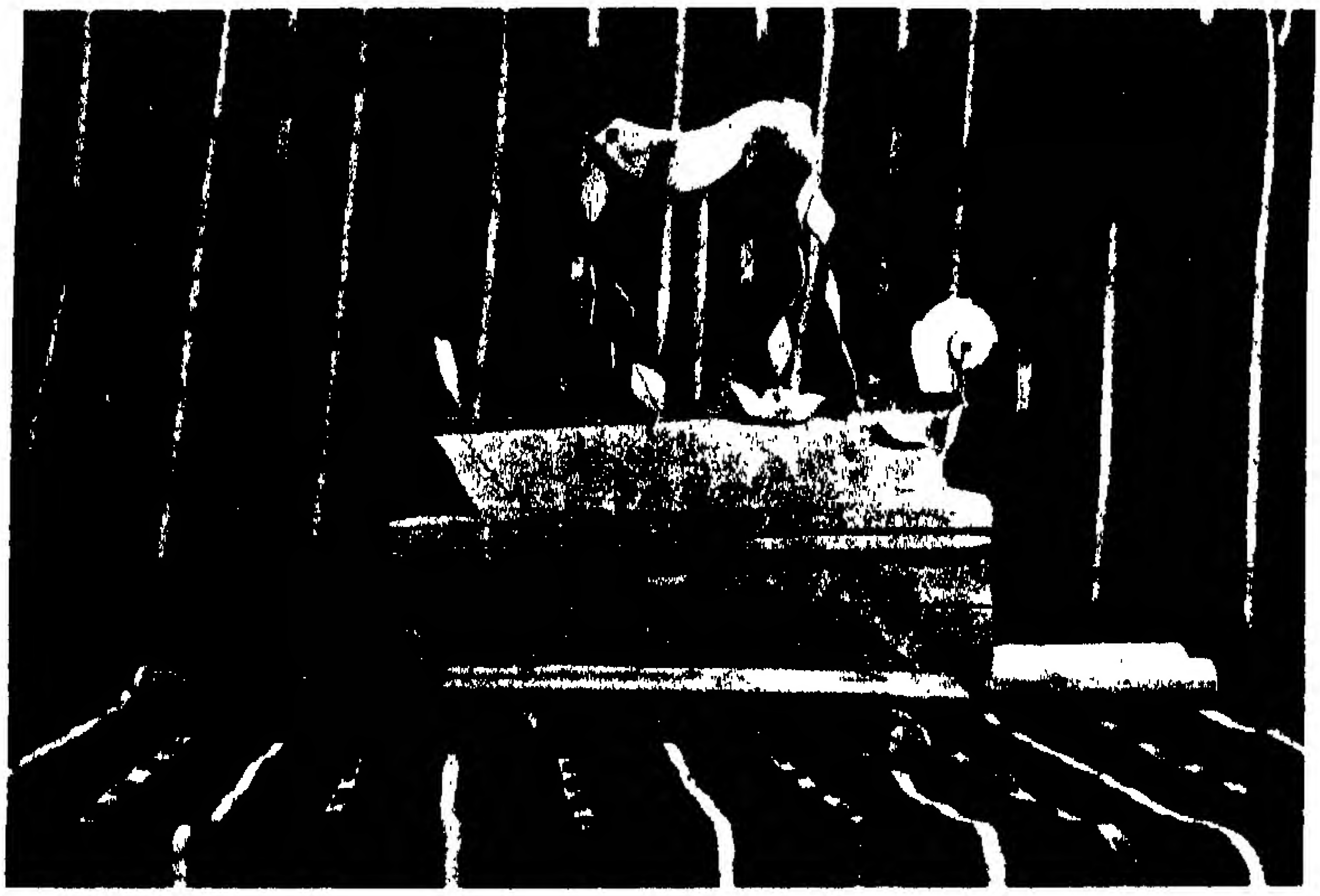

FIG. 1

FIG. 2

PLATE XXII

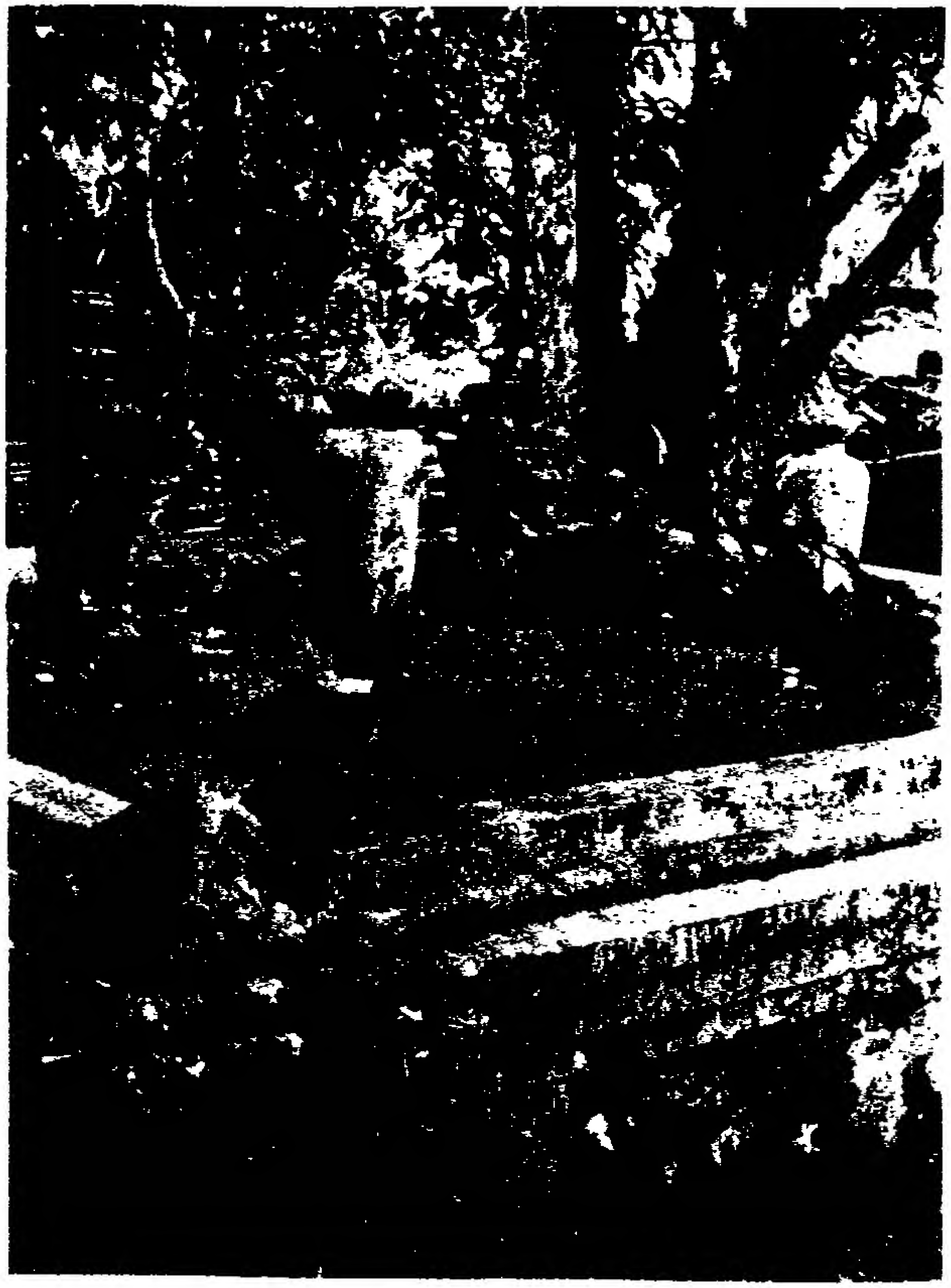

Fig. 1

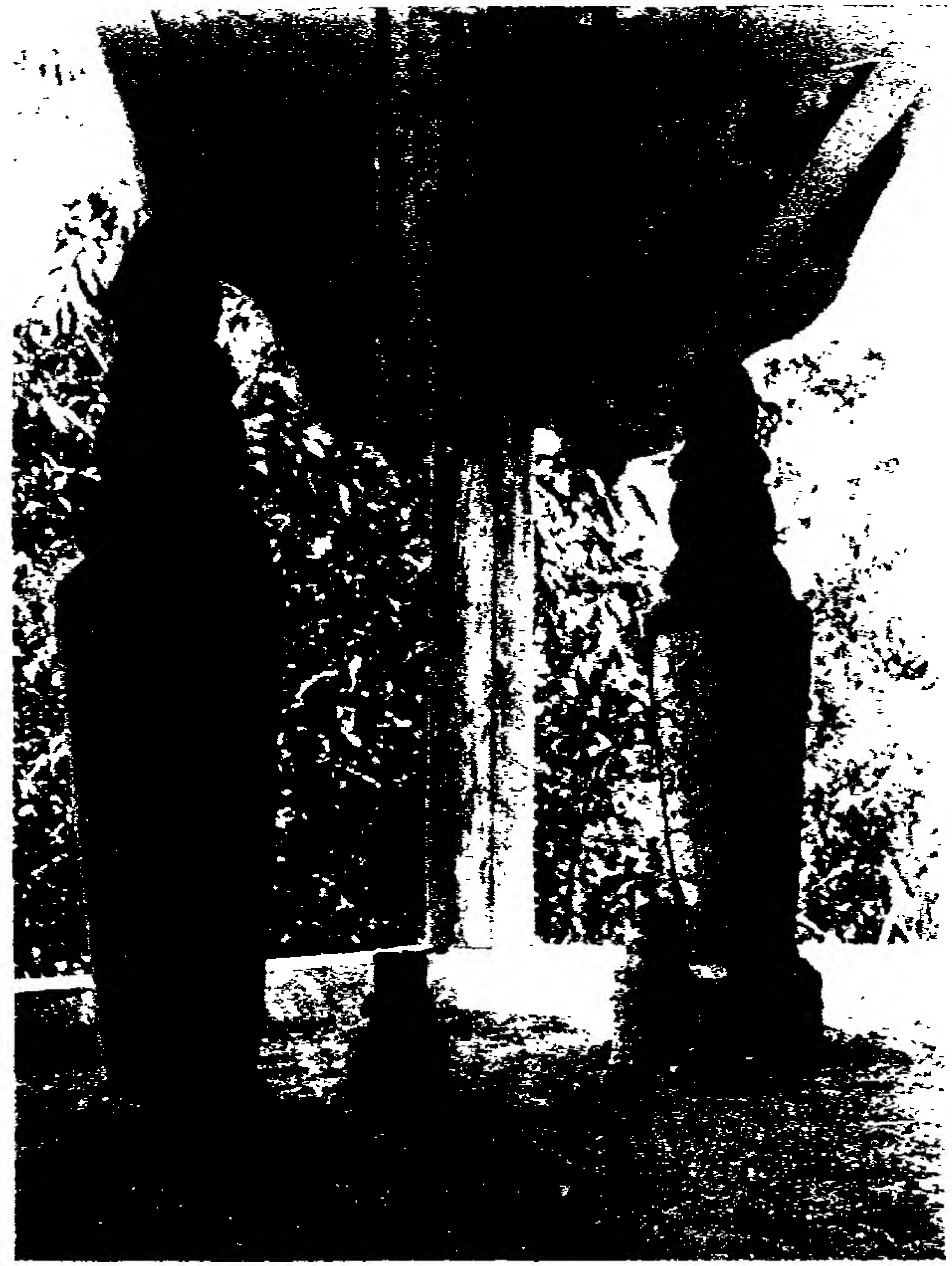

Fig. 2

PLATE XXIII

PLATE XXIV

Fig. 1

Fig. 2

Fig. 3

PLATE XXV

Fig. 1

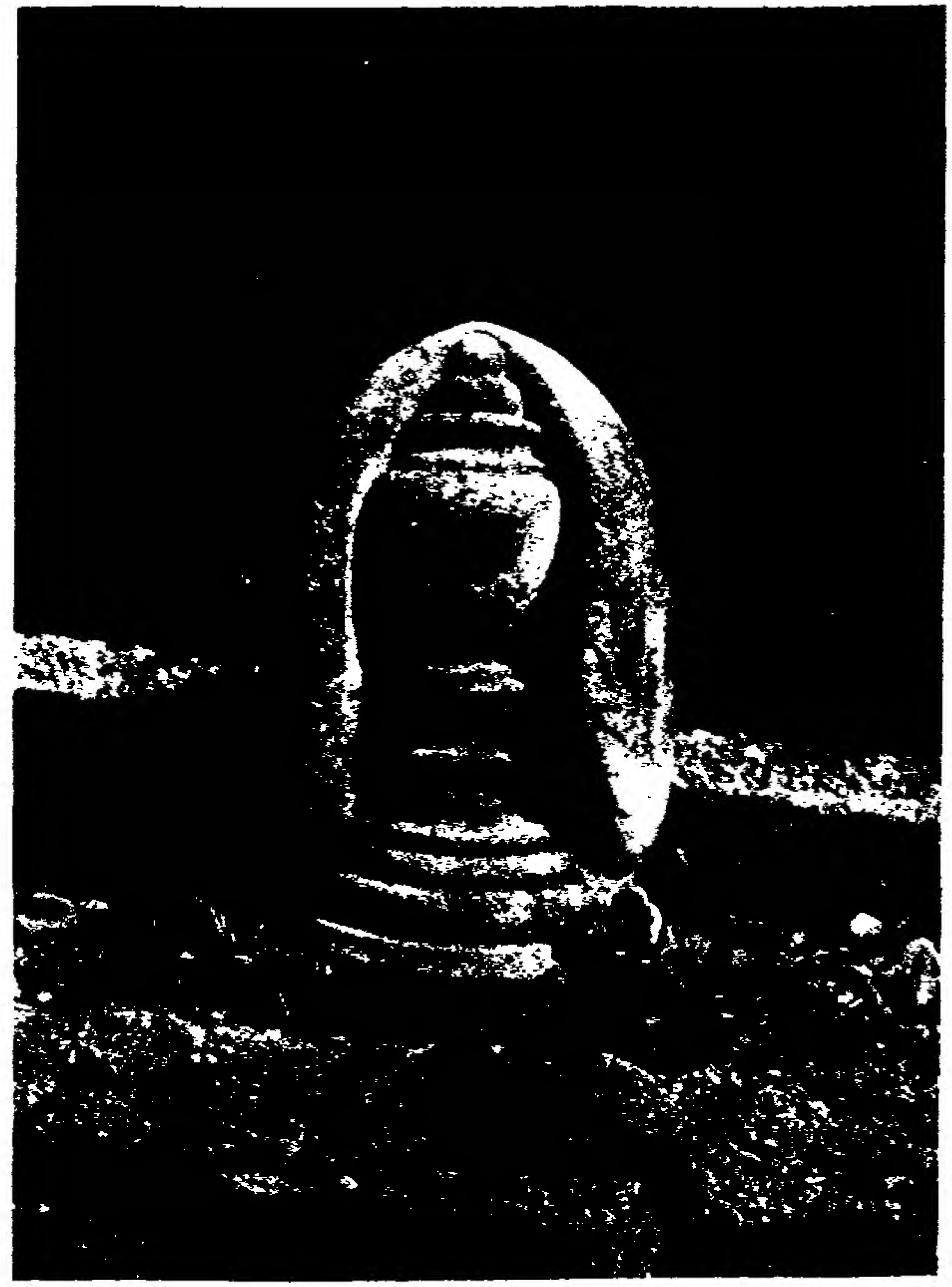

Fig. 2

NYMPHAEA MICROPHYLLA IN MICHIGAN

E. A. BESSEY

Among the yellow-flowered water-lilies native to the United States, the species known now as *Nymphaea microphylla* Pers. has the smallest flowers of any species of the genus, except possibly the closely related *N. pumila* of Europe, with which this is sometimes united. The leaves are small, rarely over two inches long; the flowers when fully opened are about three-quarters of an inch in diameter. This species was reported (under the name *Nuphar kalmianum* R. Br.) from Saginaw Bay and southwestern Michigan in Winchell's catalogue, in the southern tier of counties in Wright's catalogue, and along the shore of Lake Superior in Agassiz's report on that region.

No specimens, however, are to be found in the herbarium of the University of Michigan, or in Dodge's herbarium now in the Zoological Museum of the University, or in the herbarium of the Michigan Agricultural College, except from points in the eastern part of the United States. Miller and Standley in their monograph on this genus do not record it in the United States farther west than western New York, although it has been collected in Lake Winnipeg, Manitoba.

It is of interest, therefore, that this species was found in flourishing condition in July, 1920, in Tenderfoot Lake. This lake, which is about a mile in diameter, lies partly in Vilas County, Wisconsin, and partly in Gogebic County, Michigan. The plant was abundant near the inlet where the Presque Isle River enters the lake, i.e., in Wisconsin, and similarly in abundance in the Michigan end of the lake near its outlet. In close proximity to it were numerous plants of *Nymphaea americana*, but no plants were found in flower or fruit that could be certainly identified as *N. rubrodisca*, which has been suspected of being a hybrid between these two species.

There was observed, however, in several places a plant with leaves about intermediate in size between these two species, but with no flowers or fruit. This may possibly have been *N. rubrodisca*. It may be mentioned that one of the reasons for considering the latter as an independent species was the failure of Miller and Standley to find *N. microphylla* in the United States, farther west than New York State, whereas *N. rubrodisca* is reported from western Wisconsin and eastern Minnesota. The discovery of *N. microphylla* in the extreme western part of Michigan would suggest that this reason for denying the hybrid nature of *N. rubrodisca* must be dropped.

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THE DEVELOPMENT AND ACTIVATION OF HIBERNACULA *

H. H. M. BOWMAN

Many aquatic plants, especially of the submerged and floating flora of our fresh-water lakes and streams, produce at the advent of cold weather, a special form of bud, called winter-buds or hibernacula. These break off, sink to the bottom, and lie there on the mud until the next spring while the parent plants die. In the spring these hibernacula rise to the surface, unfold the closely appressed leaves, and elongate their axes. Some genera even send out long trailing aquatic roots.

The plants which have been studied by the writer and which have been used in the experiments described below are broadly classified into two types; first, freely floating emersed plants, and second, completely submerged plants which may be floating or weakly anchored by delicate adventitious roots. Of the former group, *Spirodela polyrhiza* (L.) Schleid. and *Lemna trisulca* L. were studied. Both of these are members of the Fam. Lemnaceae and are very similar in habit and structure. The latter group was represented by *Ceratophyllum demersum* L., *Cabomba caroliniana* A. Gray and *Myriophyllum spicatum* L. Various species of Utricularia were used at different times, but as the other genera could more easily be secured and kept growing in aquaria, they only were used. Photographs and drawings of these plants and their hibernacula are given below.

The statement made in several botanical textbooks and in various biological papers, that cold weather produced these hibernacula in the genera showing the peculiar method of over-wintering, led the writer to try to induce the development of hibernacula during the summer season by placing Utricularia plants in culture jars and keeping them cold in refrigerators,

* In this paper the index figures refer to the entries in the bibliography.

etc. These experiments were undertaken at Cold Spring Harbor, Long Island, N.Y., at the laboratory of the Station for Experimental Evolution of the Carnegie Institution of Washington through the kindness of the director, Dr. C. B. Davenport, who placed the refrigeration facilities of the laboratory at the writer's disposal during the summer of 1920.

Some results were noted, namely, that by putting the cultures into the refrigerator for increasing periods of time at first on alternate days and later daily, at a temperature of five degrees Centigrade, until after two weeks they remained all day in the refrigerator, these Utricularia plants began to form short buds like the characteristic hibernacula of the genus. The growth of the stem axis was slowed down and the latest leaves were progressively smaller and appressed. But the factors causing these results were too complex to permit the dictum that these buds were formed by the slowing down of the metabolism of the plants by the low temperature. The refrigerator was dark, and hence these experiments were not sufficiently simplified to prove anything definite concerning the formation of the hibernacula.

During September and October of both 1919 and 1920, plants were brought for study into the laboratory here at the University from inlets along Maumee Bay, a bay in the west end of Lake Erie. These plants constitute the group of species on which the following observations were made and comprise the duckweeds, water-milfoils and hornworts mentioned above. They were placed in aquaria on a table in the laboratory beside a large window and kept under observation with daily temperature readings from October to May. During this entire period the aquaria were maintained almost constantly at a temperature of 15–18° C.

The reactions in the plants were of two types dependent on the characters and habits of the various genera. The floating genera, Spirodela and Lemna, maintained themselves quite well during all of October and the early part of November, with the fronds dividing and producing new plants quite freely. During the middle of the latter month, these floating species

gradually ceased forming new plants, and the large fronds turned yellow and finally white, and started to disintegrate by decay or were eaten by the tiny Crustacea and Mollusca with which the aquaria abound. In Spirodela the buds which were pushed out from the older fronds did not broaden out, but remained small and became considerably thicker. These tiny thick fronds or buds had a crescentic zone or band of violet or reddish pigmented cells on the flattened sides. The short fronds, lenticular or somewhat chestnut-like in shape, sank to the bottom at the disintegration of the parent frond and constituted the winter-buds or hibernacula of this genus. (Pl. XXVI, Fig. 1.)

In *Lemna trisulca* L., a closely related genus, the process in the formation of the hibernacula is slightly different. The fronds of mature and actively vegetating plants cohere slightly by long slender threads between the broadly lanceolate blades of the fronds, so that a rapidly growing group of Lemna plants during the vegetative season represents a series of small, green, oblong-lanceolate blades lying at right-angles to one another and connected by narrow elongated strands of leaf tissue. When, however, the hibernacula begin to form, the plants do not develop these slender connecting strands and the blades of the fronds are reduced in size also, but division keeps on so that in a short time there is formed a miniature pile of overlapping tiny oblong blades. These little mats of green scales float about for a while and then sink, thus carrying the Lemna over the winter season when the lakes and ponds are frozen on the surface.

The submerged aquatic genera, Ceratophyllum, Cabomba, and Myriophyllum, also thrive in the aquaria and put forth new leaves and elongate the shoot axes during the early part of the fall. But in November the stem elongation stops gradually, the older leaves turn brownish or yellow and become covered with diatoms or are eaten by snails, etc. The leaves put out at the growing apex are less and less expanded and with the lack of elongation in the stem axis come to be appressed, and finally the end of the shoot is merely a small rounded or cylindrical

roll of unexpanded leaves. This ball or bud of leaves persists on the old stems in the quiet water of the tanks until long after all the old leaves on the stems have disappeared. The buds are ultimately broken from the old stems by the slow decay of the stems, or the attacks of aquatic animals, or simply the mechanical action of the water during the filling of the aquaria from time to time to replace that water lost by evaporation, etc. They sink to the bottom and carry the hornworts, etc., over the winter season. Some of them are shown in Plate XXVII, Figure 1.

The Cabomba was the only one in which the old stems did not die. These plants were anchored by their roots in the mud on the bottom. During the hibernating season they simply stop active growth and the stem apices form close, tight whorls of reduced leaves with short internodes between them. With the total disappearance of the floating flora and the disintegration of the hornworts and water-milfoils, the aquaria presented an appearance almost empty of vegetation, except for the stems of Cabomba, which spread its short thick branches with reduced green leaves close to the mud on the bottom. This was the condition of the plants during the holiday season and the early part of January; all these changes had taken place at a temperature of 15° to 18° Centigrade.

During the winter months the hibernacula, especially of Spirodela and Myriophyllum, were examined as to their contents. Sections were cut and the material treated with various reagents. The tiny lenticular hibernacula of Spirodela when picked up from the bottoms of the aquaria are found to be thickly packed with starch granules. Sections of the winter-buds of the two submerged forms, the hornworts and the water-milfoils, when treated with chloriodide of zinc, show that the bases of the thickened reduced leaves are also full of starch. The cause of the sinking of these hibernacula has been assumed to be the gradual accumulation of starch in their tissues until the cells are almost solidly filled. This so changes the specific gravity relations of the tissue to the water that they sink, since starch is of course considerably heavier than water.

In the latter part of February and early March the plants begin to grow. The submerged forms especially show elongation of the internodes, as seen in Cabomba. The spherical balls of Ceratophyllum and the more cylindrical rolls of Myriophyllum also slowly unfold their appressed leaves and elongate their axes. The outer leaves of these detached hibernacula are brown or black and covered with diatoms. With these, the tiny new leaves of a pale green color contrast strikingly. Cabomba, which remains alive in all its parts, retains of course its green leaves all winter. The *Lemna trisulca* also, in which the hibernacula are tiny flat mats of oblong fronds several layers thick, spread apart and develop the characteristic slender threads between the daughter-fronds.

It is in Spirodela that the nicest adaptation to the hibernacula habit is made. The small lenticular bodies, with their zones of colored cells in the integument of the flattened sides, are filled with starch after lying on the muddy bottom all winter. In the aquaria, then, during February and March these hibernacula slowly assume an upright position on their narrow edges and as slowly begin to ascend in the quiet water of the tank. This slow rise to the surface in an aquarium only a foot deep may occupy almost an entire afternoon. When the surface has been gained, the hibernaculum again assumes its horizontal position, and in a day or two there protrudes from the more pointed end a new frond which first appears as a very tiny, light green bud. This soon grows larger than the hibernaculum itself and the Spirodela plant has once again taken its summer form. Each plant shortly acquires three or four ovate or elliptic fronds of various sizes and a dependent cluster of roots from the purplish undersides of the fronds.

These groups of fronds soon break apart and the plant continues to propagate vegetatively all summer. When a hibernaculum of Spirodela is taken just after it reaches the surface of the water and is macerated with some chloriodide of zinc, the contents react very strikingly to the reagent. The soft cells of the hibernaculum pour out their contents rather slowly. If

a little pressure is exerted on the cover-slip, the deeper and more centrally placed portions of the protoplasmic contents are pushed out the farthest. This is filled with starch grains and takes on a deep blue color. The cells just within the epidermis and the chlorenchyma are not thrust out so far by the pressure, and these have contents which take on a reddish-violet color indicating dextrin. (See Pl. XXVI, Fig. 2.)

These cells contain, as do also the chlorenchymatic cells just beneath the epidermis, numerous bundles of delicate raphides. These cellular inclusions abound in the vegetative fronds of Spirodela. It is assumed that the starch in the hibernacula is slowly hydrolized to dextrin, and ultimately to sugar by some enzyme, and that this produces in the specific gravity relations between the hibernacula and the water the necessary changes to cause them to ride to the surface.

But what causes the activation, then, of this amylytic enzyme? The older references mostly agree that the sinking and the rising of the hibernacula are associated with temperature changes. Coville [1] in his work with Vaccinium and other Ericaceae found that when the dormant twigs filled with starch were exposed to low temperatures, and then brought into greenhouse conditions, the starch was converted into sugar and the shoots made rapid growth; the cold apparently activated an amylytic enzyme.

Another observation made by Pond [2] on the storage of starch in submerged aquatics seems to be connected with this group of photosynthetic phenomena. He found that aquatic plants whose normal growth rate is checked begin to store up starch, and eventually contain more than normal shoots. An attempt to throw some light on the factors concerned in these phenomena will be made in the following discussion of the activation of hibernacula and their starch content. In the case of the present experiments, however, it must be stated that a very significant fact is that the hibernacula were developed, the dormant stage was passed through, the activation of the hibernacula occurred, and the vegetative stage was resumed, all with a very slight if any change in temperature.

As was stated earlier, the temperature of the aquaria was maintained fairly constant between 15° and 18° Centigrade. The only factor which did vary within any great range was the light each day. The shortening of the diurnal illumination during the fall and its lengthening during the spring months constitute the greatest change in these observations, and it was especially with the idea of noting the effect of this variation in the quantity of daily light received by these plants, rather than temperature changes, that these studies were made.

DEVELOPMENT OF HIBERNACULA

In the first place, it has long been known that light is of the greatest significance in carbohydrate synthesis. Krascheninnikoff [3] showed by direct experimentation that only a short exposure to light caused an appreciable increase in the dry weight, the amount of carbohydrate formed, the heat of combustion, etc. He removed the half-leaves from certain plants and measured their leaf areas; these halves were then measured for carbohydrate content, dried, weighed, and burned, and the heat of combustion calculated for each meter of square surface. The remaining half-leaves were exposed to light for short intervals and then treated just as the first set of half-leaves had been and the data compared. These data showed that in all the half-leaves exposed for the longer period, there were increases in the quantities per square meter. In carbohydrates alone, he found there was an increase of 2.40 grams per square meter. From these experiments it is seen that differences in length of time of exposure to light, that is, the day, would make a great difference in the total amount of carbohydrate synthesized during the entire day. Since the hibernacula of these plants are storage organs for carbohydrates, we are concerned especially only with this phase of synthesis, but of course the amount of CO_2 decomposed and the other processes also must be considered along with the synthesis of carbohydrates.

Schaffner [4] recently has shown that the decrease in daily total of light in the fall and winter seasons so reduces synthesis

and nutrition in greenhouse cultures of hops and hemp that premature flowers and peculiar sexual aberrations are produced in these plants, and that it is all dependent on the metabolic condition of the plants induced by the daily quantity of light.

Temperature can not be considered the prime causative factor in the production of hibernacula and the consequent storage of carbohydrate for reserve food since the plants considered in this paper were kept at practically a uniform temperature during the whole period of observation. Temperature has been found to have very little effect on synthesis as recorded by Kreusler.[5] He has demonstrated that photosynthesis is only slightly affected by temperature and that the decomposition of carbon dioxide begins almost at the freezing point and continues up to nearly fifty degrees Centigrade. His data show that if the amount of carbon dioxide decomposed in a unit of time at 2.3 degrees C. be represented by 1 and a gradual rise in temperature be made, the increased amount of decomposition represented by 3 is not yet reached even at 25° C. The respiration figure is of course increased many times by the raising of the temperature to that point. In the light of these facts if we assume that a decrease in the amount of daily carbohydrate synthesis is the initiating factor in the production of hibernacula, we must also assume that since low temperatures do not reduce carbohydrate synthesis materially, the low temperature is not the cause of the development of these winter-buds, or starch-storage organs, and the old view that the advent of the cold weather in autumn causes these aquatics to develop hibernacula is illogical.

THE ACTIVATION OF HIBERNACULA

As set forth above, the hibernacula of the plants studied here become active, and expand their fronds or leaves and elongate their axes during the early spring months in the aquaria in which they had been kept at a uniform temperature all winter. The thickened storage frond or bud of Spirodela and Lemna and the closely folded and appressed leaves of the submerged milfoils and hornworts are filled with starch. During

the process of activation, this starch is transformed into dextrin and ultimately to dextrose. With the gradual disappearance of the starch and consequent lightening of the hibernaculum, this organ rises slowly and floats on the surface as in the case with the duckweeds. The hydrolysis of this starch is due to the activation of an amylytic enzyme, presumably diastase.

It is, then, pertinent to this discussion to consider the causes for the starting into activity of this enzyme in the dormant hibernaculum lying on the muddy bottom of the tank. Diastase, according to Palladin,[6] is the most widely distributed of the plant enzymes, and is, as shown by chemical experiments, very forceful. A very small amount of diastase is able to hydrolize large quantities of starch; thus one part by weight of the enzyme will hydrolize 2,000 parts of starch. Baronetsky,[7] who studied the distribution of diastase, showed its abundance in germinating seeds, and proved that its action is hastened by higher temperature up to 45° C. and 50° C.

But aquaria in which these hibernacula were kept had a constant temperature of 15 to 18 degrees C. for nearly all the period until April. Notwithstanding the fact that this temperature was considerably below the optimum temperature of possibly 33 or 38° C., at which diastase hydrolizes starch, the starch was hydrolized and the lower temperature did not seem to inhibit its action, since, when germinating hibernacula are tested with chloriodide of zinc, there are indicated the presence of dextrin and a decrease in the reserve starch. The lower temperature and the consequent slower hydrolysis may possibly account for the very slow and gradual rise of the hibernacula when they become active. Three to five hours are sometimes necessary for one to ascend through a foot of water.

Another factor which may account for the very gradual transformation of the starch into glucose may be that these tiny aquatics have possibly a very low diastatic power. Brown and Morris [8] found a great variability in this power in different plants. The leaves of the garden pea, for instance, have a diastatic efficiency of 240.30 while *Hydrocharis morsus-ranae*, a lowly aquatic, has an efficiency represented by only .26. Thus it may

be that these aquatic plants have such low indices of diastatic efficiency in general, and in addition to this, since the buds are very small, it would take considerable time to hydrolize all of the starch in them to sugar, if the proportion of diastase present is smaller and in low rate of efficiency.

But to return to the facts observed on these particular plants, it appears that the most important factor in the activation of these hibernacula is light. Regardless of the constancy of temperature, the buds became active with the increased daily total of light in March and February. Elaborate studies on the development of asparagin in plant tissues have been made by Pfeffer,[9] as well as by Meunier,[10] Borodin [11] and Schultze.[12] These works show that light and darkness are very great factors in the increase and decrease of asparagin. Asparagin formation is of course directly concerned with the decomposition of carbohydrates since, as Palladin [13] remarks, "the formation of asparagin is to be considered as strictly analogous to the formation of urea in animals, but urea is eliminated from the animal body while asparagin is again utilized in the plant body by means of the energy of sunlight."

The effect of light on the decomposition of plant products is further shown by Schultze's work on oat seedlings. Some seedlings grown in light were tested for protein content, and after a week in darkness others of the same lot were tested again. The table taken from Palladin shows the transformation from increase to decrease and vice versa for the amounts of nitrogen, of proteins, and the non-protein nitrogens.

The following table shows the variation in the amount of asparagin in plants grown in darkness and in light:

Age of plants in days	Amount when grown in darkness	Amount when grown in the light
13	1.13	1.18
18	2.28	2.25
38	5.18	1.41

In view of these researches on the decomposition of proteids, with reference to light and the synthesis of proteids from carbohydrate materials, and the well-known facts of the action of

diastase and other enzymes on starch, etc., we may again quote from Palladin [14] when he says: "In the general influence of light upon plant growth and structure, many different kinds of reactions have been found to take part, such as oxidation, polymerization, decomposition, and even synthesis. Neuberg [15] was right when he wrote 'these rapid chemical reactions caused by light may furnish a clue to the chemical processes that underlie phototropic responses, and even to the nature of sunlight effects in general, upon both plants and animals.'" Palladin also refers to the work of Ciamician [16] and says: "The importance of light to plants is not confined to the photosynthesis of carbohydrate from carbon dioxide and water; light is necessary for the occurrence of very many kinds of chemical reactions in plants.

"Among the investigations that already testify to this are those upon the influence of light in protein formation. Numerous other reactions that are influenced by light, and that are purely chemical in nature, furnish additional evidence upon this point. Ciamician and Silber were able to establish the fact that very many oxidations, reductions, hydrolyses, polymerizations, and condensations are affected by light; such changes may progress very rapidly when an inorganic substance is involved." With regard then to the reserve food of these hibernacula, we may say that the increased total amount of diurnal light of the early spring months so influences the enzymes of these structures that they become activated, and hydrolize the reserve starch into a more soluble form of food which is used in the plant's metabolism and renewed growth, as is evidenced by the rise to the surface of the water and the resumption of the vegetatic form characteristic of the summer months.

SUMMARY

In summarizing these observations it may be said that these data were collected on cultures of duckweeds, water-milfoils and hornworts kept in aquaria in the laboratory at practically a constant temperature of 15° to 18° Centigrade, from October to May for a period of over two years.

During these periods these plants formed hibernacula which lay dormant and then became activated successively without changes in temperature taking place. Chemical examination of the contents of dormant hibernacula showed a repletion of starch; of activating hibernacula, showed the presence of dextrin.

Light was the most variable physiological factor entering into these observations, showing a decrease in the total day illumination in the fall and an increase in the spring.

Reference to earlier and recent researches on the nature of the chemical processes of plants furnish abundant evidence that temperature is not of great importance in many of these processes, and that the light factor would be adequate to explain the initiating energy displayed in many of the complex chemical reactions which take place in the development and activation of these winter-buds.

It is then here set forth that in the physiological processes involved in the formation and activation of the hibernacula of the plants included in these observations light, and not temperature, is the causative factor.

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PLATE XXVI

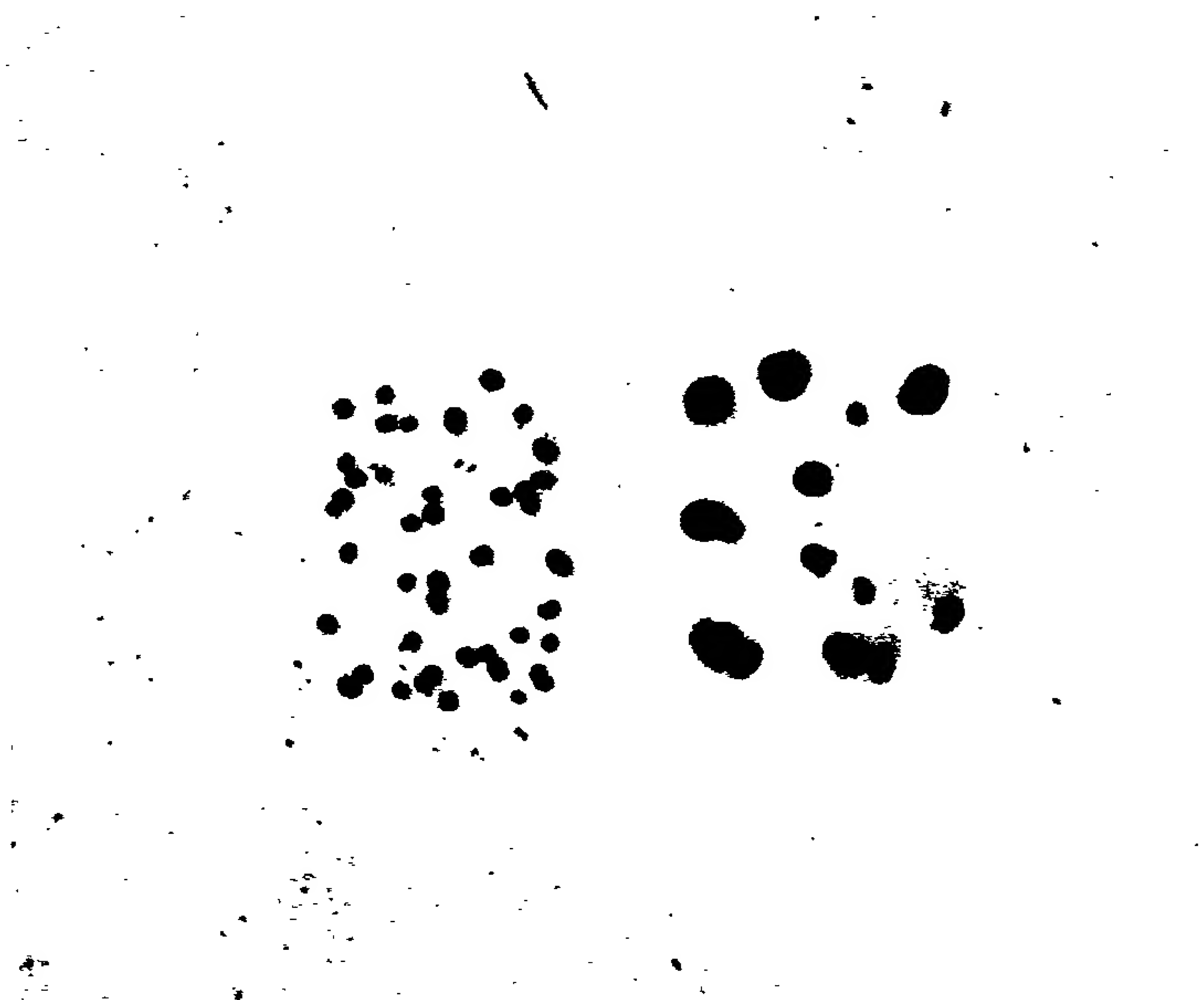


FIG. 1. Hibernacula of SPIRODELA POLYRHIZA on the Left and Vegetative Plants on the Right. (Natural Size)

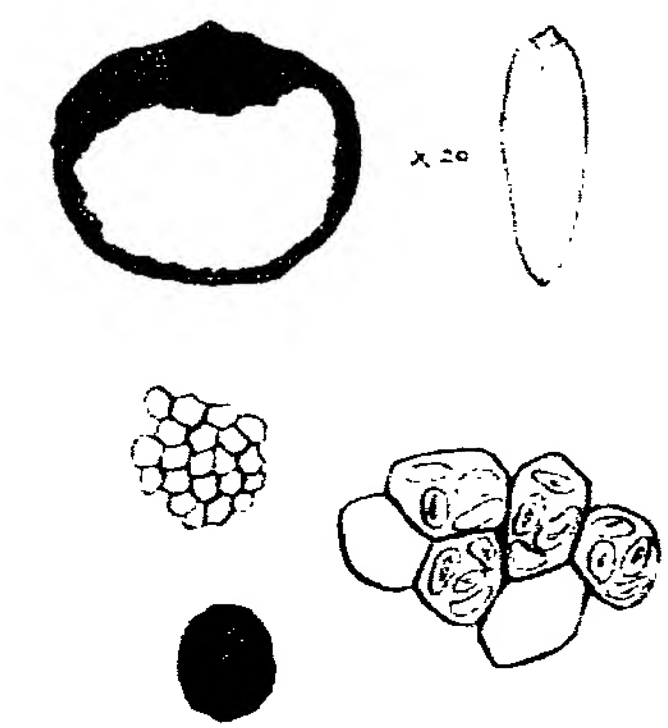
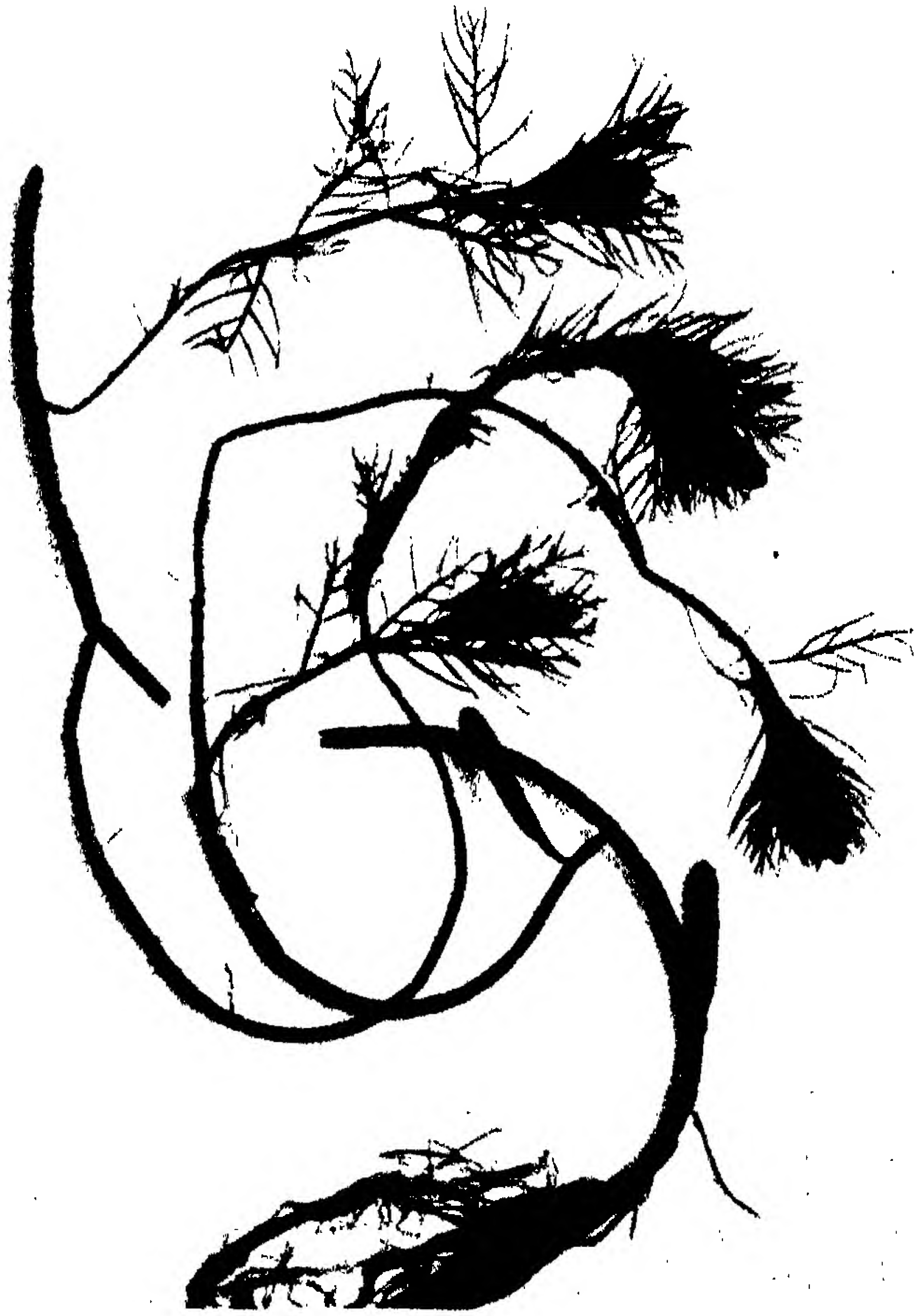


FIG. 2. Detail of a Hibernaculum of Spirodela showing Pigment Zone, Lateral View, Epidermal Cells, and Parenchymatic Cells containing Starch Granules.

PLATE XXVII



Plant of Myriophyllum spicatum, showing Cylindrical Hibernacula still Attached Below.

PLATE XXVIII

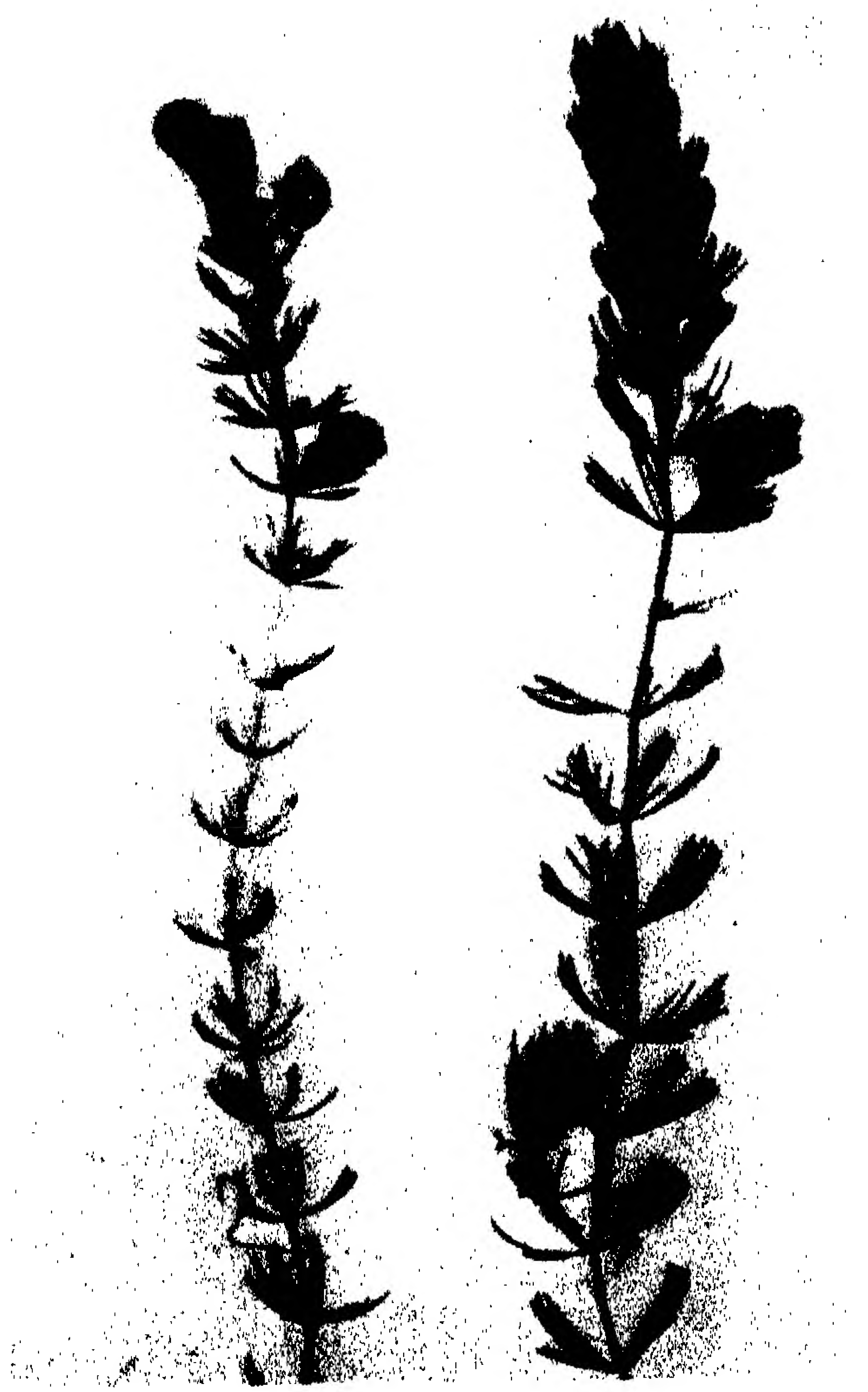


FIG. 1. Plants of CERATOPHYLLUM DEMERSUM L., showing Hibernaculum Formation on the Left.

FIG. 2A. Detail of a Hibernaculum Myriophyllum and Portion of Leaf showing Starch in Cells.

2B. Detail of a Hibernaculum of Ceratophyllum, showing Starch Storage in Leaf Bases and Isolated Starch Granules.

PLATE XXIX

Plant of Cabomba caroliniana A. Gray, showing the Winter Condition and Appressed Leaf Buds in the Formation of Hibernacula.

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CONTRIBUTIONS TO THE FLORA OF GOGEBIC COUNTY, MICHIGAN

PART II[1]

H. T. DARLINGTON

In the early part of the summer of 1920, work on the floral survey of Gogebic County was continued in coöperation with the Michigan Geological and Biological Survey. The principal effort was directed toward getting the early spring flora. The writer did most of his collecting in the vicinity of Ironwood and Bessemer and along the Lake Superior shore near the mouth of Montreal River. This was during the early part of June. A few weeks later, Dr. E. A. Bessey collected again in the vicinity of Bent's Camp in the southeastern part of the county.

This paper lists approximately one hundred additional species of ferns and flowering plants that were found, bringing the total number listed for the County above six hundred. We keenly realize that further search would reveal more species, though we believe the species included in Parts I and II of this report represent a fairly typical cross-section of the vegetation of this part of Michigan. A third paper by Dr. Bessey will list all the fungi seen during the two seasons' work. Acknowledgments are made to Dr. A. K. Peitersen of the Colorado State Agricultural College for the determination of those species of Rubus belonging to the Eubatus group.

OPHIOGLOSSACEAE (Adder's Tongue Family).

Botrychium neglectum Wood. Wood's Grape Fern. Common at one place near Fish Hawk Lake.

[1] For Part I, see Vol. 22, pp. 147–176.

POLYPODIACEAE (Fern Family).

Dryopteris spinulosa (Muhl.) Kuntze. Spinulose Shield Fern. Woods, vicinity of Thousand Island Lake. Probably throughout. Collected by E. A. B.

ZANNICHELLIACEAE (Pondweed Family).

Potamogeton epihydrus Raf. Nuttall's Pondweed. Tenderfoot Lake. Collected by E. A. B.

POACEAE (Grass Family).

Panicum huachucae Ashe. Hairy Panic-Grass. Vicinity of Thousand Island Lake. Collected by E. A. B.

Savastana odorata (L.) Scribn. Holy Grass. Vicinity of Bessemer. Not common.

Oryzopsis pungens (Torr.) Hitchc. Slender Mountain-Rice. Dry ground, summits of the Gogebic Range.

Oryzopsis asperifolia Michx. White-grained Mountain-Rice. In the Gogebic Range. Very common in places.

Alopecurus pratensis L. Meadow Foxtail. Roadside, one place near Ironwood. Introduced.

Calamagrostis inexpansa A. Gray. Bog Reed-Grass. Near Record Lake. Collected by E. A. B.

Avena torreyi Nash. Purple Oat. Rocky ridges in the Gogebic Range. Common in exposed places.

Panicularia borealis Nash. Northern Manna-Grass. Lake region. Collected by E. A. B.

Lolium perenne L. Perennial Rye. In lawns at Ironwood. Introduced.

CYPERACEAE (Sedge Family).

Eriophorum callitrix Cham. Sheathed Cotton-Grass. Sphagnum bogs near Ironwood.

Eriophorum angustifolium Roth. Tall Cotton-Grass. Sphagnum bogs near Cisco Lake. Collected by E. A. B.

Eriophorum viridicarinatum (Engelm.) Fernald. Thin-leaved Cotton-Grass. Low ground near Fish Hawk Lake.

Carex rosea Schk. Stellate Sedge. Woods near Bessemer.

CAREX DIANDRA Schrank. Lesser Panicled Sedge. Low ground near Fish Hawk Lake.

CAREX STIPATA Muhl. Awl-fruited Sedge. In ditches near Ironwood.

CAREX CANESCENS L. Silvery Sedge. Wet, open ground. Very common in places.

CAREX DEWEYANA Schwein. Dewey's Sedge. Dry woods and fields. Frequent.

CAREX BROMOIDES Schk. Brome-like Sedge. Near mouth of Montreal River.

CAREX LEERSII Willd. Little Prickly Sedge. Low ground. near Fish Hawk Lake. Collected by E. A. B.

CAREX TRIBULOIDES Wahl. Blunt Broom Sedge. Low ground near Thousand Island Lake. Collected by E. A. B.

CAREX CRISTATELLA Britton. Crested Sedge. Northern shore of Tenderfoot Lake. Collected by E. A. B.

CAREX STRAMINEA Willd. Straw Sedge. Dry soil. Along roadsides near Watersmeet.

CAREX PENNSYLVANICA Lam. Pennsylvania Sedge. Dry rocky soil in the Gogebic Range.

CAREX VARIA Muhl. Emmon's Sedge. Dry rocky summits of the Gogebic Range. Frequent.

CAREX PLANTAGINEA Lam. Plantain-leaved Sedge. Rocky woodlands near Ironwood.

CAREX ANCEPS Muhl. Two-edged Sedge. Woods near Ironwood.

CAREX STRICTA Lam. Tussock Sedge. Low open ground near Ironwood.

CAREX CRINITA Lam. Fringed Sedge. Sphagnum bog near Cisco Lake. Collected by E. A. B.

CAREX LACUSTRIS Willd. Lake-bank Sedge. Moist, sandy, open ground near Fish Hawk Lake.

CAREX LANUGINOSA Michx. Woolly Sedge. Banks of Montreal River near Ironwood.

ARACEAE (ARUM FAMILY).

ACORUS CALAMUS L. Sweet Flag. One place near Bessemer. Apparently not common.

JUNCACEAE (RUSH FAMILY).

JUNCOIDES CAROLINAE (S. Wats.) Kuntze. Hairy Wood-Rush. Frequent in woods near Bessemer.

LILIACEAE (LILY FAMILY).

ALLIUM TRICOCCUM Ait. Wild Leek Woods near Bessemer. Occasional.

ERYTHRONIUM AMERICANUM Ker. Yellow Adder's Tongue. Moist woods near Bessemer.

CONVALLARIACEAE (LILY-OF-THE-VALLEY FAMILY).

VAGNERA TRIFOLIA (L.) Morong. Three-leaved Solomon's Seal. In bogs near Bessemer.

UVULARIA SESSILIFOLIA L. Sessile-leaved Bellwort. In thickets near Bessemer.

POLYGONATUM BIFLORUM (Walt.) Ell. Hairy Solomon's Seal. Woods in the Bessemer-Ironwood region.

TRILLIACEAE (WAKE ROBIN FAMILY).

TRILLIUM GRANDIFLORUM (Michx.) Salisb. Large-flowered Wake Robin. Woods in the Bessemer-Ironwood region; also in the Gogebic Range.

ORCHIDACEAE (ORCHID FAMILY).

CYPRIPEDIUM PARVIFLORUM var. PUBESCENS (Willd.) Knight. Large Yellow Ladies' Slipper. Woods at the mouth of the Montreal River. Scarce.

POGONIA OPHIOGLOSSOIDES (L.) Ker. Rose Pogonia. Near Fish Hawk Lake. Collected by E. A. B.

LIMODORUM TUBEROSUM L. Grass-pink. Bog in Fish Hawk Lake. Collected by E. A. B.

OPHRYS CORDATA L. Heart-leaved Twayblade. Bog near Ironwood. In sphagnum moss.

SALICACEAE (WILLOW FAMILY).

SALIX NIGRA Marsh. Black Willow. Along the Montreal River near Ironwood. Infrequent.

Salix sericea Marsh. Silky Willow. Low ground near Bessemer. Infrequent.

BETULACEAE (Birch Family).

Betula alleghaniensis Britton. Southern Yellow Birch. Collected by E. A. B.

URTICACEAE (Nettle Family).

Urtica lyallii S. Wats. Lyall's Nettle. Mouth of the Montreal River.

PORTULACACEAE (Purslane Family).

Claytonia virginica L. Spring Beauty. Woods, Bessemer-Ironwood region.

ALSINACEAE (Chickweed Family).

Alsine borealis (Bigel.) Britton. Northern Stitchwort. Wet ground, occasional. Collected by E. A. B.

NYMPHAEACEAE (Water Lily Family).

Nymphaea microphylla Pers. Small-leaved Nymphaea. Collected by E. A. B. in Tenderfoot Lake.

RANUNCULACEAE (Crowfoot Family).

Anemone quinquefolia L. Wind-Flower. Moist woods, Bessemer-Ironwood region, frequent. Probably throughout.

Ranunculus abortivus L. Smooth-leaved Crowfoot. Moist woods, frequent.

PAPAVERACEAE (Poppy Family).

Sanguinaria canadensis L. Bloodroot. Woods, Bessemer-Ironwood region. Common.

FUMARIACEAE (Fumewort Family).

Bicuculla cucullaria (L.) Millsp. Dutchman's Breeches. Rich woods in the Bessemer-Ironwood region.

CRUCIFERAE (Mustard Family).

Cheirinia cheiranthoides (L.) Link. Wormseed Mustard. Bent's Camp. Probably introduced.

Barbarea barbarea (L.) MacM. Yellow Rocket. Occasional in the Bessemer-Ironwood region.

Arabis brachycarpa (T. & G.) Britton. Purple Rock-Cress. Rocky soil in the Gogebic Range. Near Bessemer.

Cardamine pennsylvanica Muhl. Pennsylvania Bitter-Cress. Wet woods, Bessemer-Ironwood region. Occasional.

Cardamine parviflora L. Small-flowered Bitter-Cress. Edges of rocks in the Gogebic Range. Occasional.

Dentaria laciniata Muhl. Cut-leaved Toothwort. Moist woods, Bessemer-Ironwood region.

Dentaria diphylla Michx. Two-leaved Toothwort. Rich woods, Bessemer-Ironwood region. Apparently not common.

Sinapis arvensis L. Charlock. Introduced weed. Occasional in the Bessemer-Ironwood region.

CRASSULACEAE (Orpine Family).

Sedum triphyllum (Haw.) S. F. Gray. Orpine. Roadsides, occasional. Near Bessemer.

SAXIFRAGACEAE (Saxifrage Family).

Micranthes pennsylvanica (L.) Harv. Swamp Saxifrage. Low, open ground, Bessemer-Ironwood region.

Mitella diphylla L. Two-leaved Bishop's Cap. Rocky gorge near mouth of Montreal River.

ROSACEAE (Rose Family).

Drymocallis agrimonioides (Pursh.) Rydb. Tall Cinquefoil. Rocky soil in the Gogebic Range. Near Bessemer.

Geum macrophyllum Willd. Large-leaved Avens. Woods near mouth of Montreal River.

Rubus triflorus Richards. Dwarf Red Blackberry. Wet woods, common throughout.

Rubus canadensis L. Millspaugh's Blackberry. In thickets, common.

MALACEAE (Apple Family).

Sorbus scopulina Greene. Mountain Ash. Wet ground. Specimens collected by E. A. B.

Amelanchier huronensis. Juneberry. Summits of the Gogebic Range. Near Bessemer.

FABACEAE (Pea Family).

Lathyrus ochroleucus Hook. Pale Vetchling. Sandy woods near mouth of Montreal River.

GERANIACEAE (Geranium Family).

Geranium maculatum L. Spotted Crane's-Bill. Woods near Ironwood.

POLYGALACEAE (Milkwort Family).

Polygala paucifolia Willd. Fringed Milkwort. Found by E. A. B. in 1919, but not listed before.

VIOLACEAE (Violet Family).

Viola novae-angliae House. New England Blue Violet. Rocky ground, vicinity of ore piles, Ironwood. Collected by Miss Pauline Alford. Not collected before in Michigan, so far as we know.

Viola cucullata Ait. Marsh Blue Violet. Vicinity of Ironwood. Common.

Viola eriocarpa Schwein. Smoothish Yellow Violet. Low woods near Ironwood.

Viola labradorica Schrank. Alpine Violet. Woods near Ironwood.

AMMIACEAE (Carrot Family).

Sanicula sp. Snakeroot. Woods near Bessemer.

Washingtonia longistylis (Torr.) Britton. Banks of Montreal River near Ironwood. Infrequent.

Washingtonia obtusa Coult. & Rose. Woods near Fish Hawk Lake.

CICUTA MACULATA L. Cowbane. Low ground near Bessemer. Apparently not common.

CARUM CARUI L. Caraway. Roadsides, Bessemer-Ironwood region.

CORNACEAE (DOGWOOD FAMILY).

CORNUS BAILEYI Coult. & Evans. Bailey's Cornel. Mouth of Montreal River.

PYROLACEAE (WINTERGREEN FAMILY).

PYROLA CHLORANTHA Sw. Greenish-flowered Wintergreen. Collected by E. A. B. near Thousand Island Lake.

PYROLA ASARIFOLIA Michx. Liver-leaf Wintergreen. Mouth of Montreal River.

ERICACEAE (HEATH FAMILY).

UVA-URSI UVA-URSI (L.) Britton. Red Bearberry. Exposed rocks of the Gogebic Range near Bessemer. Apparently not common.

PRIMULACEAE (PRIMROSE FAMILY).

NAUMBERGIA THYRSIFLORA (L.) Duby. Tufted Loosestrife. Low swampy ground throughout. Occasional.

APOCYNACEAE (DOGBANE FAMILY).

APOCYNUM SIBIRICUM Jaeg. Clasping-leaved Dogbane. Mouth of Montreal River.

BORAGINACEAE (BORAGE FAMILY).

MERTENSIA PANICULATA (Ait.) G. Don. Tall Lungwort. Borders of woods, occasional. Bessemer-Ironwood region.

SYMPHYTUM OFFICINALE L. Comfrey. Waste ground near Bessemer. Probably escaping from cultivation.

LABIATAE (MINT FAMILY).

LYCOPUS AMERICANUS Muhl. Cut-leaved Water Horehound. Wet open ground near Bessemer.

LENTIBULARIACEAE (Bladderwort Family).

Utricularia macrorhiza LeConte. Greater Bladderwort. Shallow water in the lake region. Common.

RUBIACEAE (Madder Family).

Houstonia longifolia Gaertn. Long-leaved Houstonia. Dry rocky ground on the summit of the Gogebic Range.

Galium claytoni Michx. Clayton's Bedstraw. Moist ground in the lake region, frequent. Probably throughout.

Galium lanceolatum Torr. Wild Liquorice. Dry woods near Bessemer.

LOBELIACEAE (Lobelia Family).

Lobelia spicata Lam. Pale Spiked Lobelia. Open ground in the lake region. Infrequent. Collected by E. A. B.

COMPOSITAE (Composite Family).

Erigeron philadelphicum L. Daisy Fleabane. Meadows, vicinity of Ironwood. Not common.

Antennaria canadensis Greene. Ladies' Tobacco. This species occurs with *Antennaria neodioica* on rocky summits of the Gogebic Range.

Petasites palmata (Ait.) A. Gray. Palmate-leaf Sweet Coltsfoot. Low ground in woods near mouth of the Montreal River.

Tanacetum vulgare L. Common Tansy. Roadsides near Bessemer.

Senecio aureus L. Golden Ragwort. Common in low ground, in the Bessemer-Ironwood region.

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THE VALUE OF DOUBLE INFILTRATION IN BOTANICAL MICROTECHNIQUE *

RICHARD DE ZEEUW

At the Columbus meeting of the American Association in 1915, S. I. Kornhauser [1] reported on a double infiltration method worked out by S. Apathy.[2] To what extent it has been adopted by botanists I am not aware. Hence I considered it worth while to report on my experience with it, and also to note the modifications I have found advantageous.

In this method as outlined by the originator the material is first embedded in celloidin in the regular way.[3] The celloidin block is then embedded in paraffin and hardened in chloroform. This hardened block is then put into an oil mixture, which is said to give the chief value to the method. This oil mixture is made up as follows: chloroform, 4cc.; origanum oil, 2cc.; cedarwood oil, 4cc.; absolute alcohol, 1cc.; carbolic acid, 1 gm.

Some dried sodium sulphate is put in the bottom of the vial to take up any water that may be present. It will be noted that this mixture differs from Eycleshymer's clearing fluid in the substitution of origanum oil for bergamot oil, and the addition of some absolute alcohol and chloroform. The latter are intended, apparently, to bridge over from the chloroform in which the block was hardened. The cleared block is then transferred to benzol. The celloidin is non-soluble in these solutions. It seems to me that Eycleshymer's fluid would do as well. Since Apathy's oil mixture is not used as a solvent for the paraffin, but merely as an intermediate step, why use it at all?

The celloidin block is hardened in chloroform, which is a solvent of paraffin at the same time. Why not use it in that

* The index numbers in this paper refer to the entries in the bibliography.

way? I have found the following modification very satisfactory:

1. Infiltrate the material with medium celloidin.

2. Harden in chloroform, leaving only as much celloidin as will cling to the material when it is dropped into the chloroform.

3. Change the chloroform twice in the next twenty-four hours.

4. Add paraffin shavings, infiltrating with paraffin in the usual way.

The method offers the following advantages:

1. Delicate material does not shrink and become distorted.

2. Delicate material with hard and tough elements in it is not torn by these refractory elements.

3. Material ordinarily too hard to cut in paraffin cuts readily.

4. Sections can be cut as thin as in paraffin alone.

5. It has the advantages of both methods.

6. Material that is likely to crumble cuts as well as in celloidin alone. The sections, however, are thinner.

7. Sections may be cut on either the rotary or sliding microtome.

The celloidin matrix may be left or it may be removed, after the removal of the paraffin from the ribbon, with ether-alcohol. This is likely to cause the sections to come off the slide when ordinary fixatives are used. The use of Szombathy's [4] gelatine fixative will, I have found, overcome this difficulty.

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East Lansing, Michigan

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NOTES ON THE MICHIGAN FLORA

PART IV[1]

OLIVER ATKINS FARWELL

GRAMINACEAE

PANICUM BICKNELLII Nash var. **Bushii** (Nash) n. comb. (*Panicum Bushii* Nash; Bull. Torr. Bot. Club, 26: 568. 1899). This differs from the typical form of the species in having glabrous spikelets and villous culms and leaf-sheaths. Dearborn, Billington and Farwell, No. 4530a, July 14, 1917.

ECHINOCHOLA Beauv. On page 349 of the Twenty-First Annual Report of the Michigan Academy of Science is found the new combination, *E. Crusgalli* (L) Beauv. f. *sabulonum.* Needless to say, this should have been *E. Crusgalli* (L.) Beauv. f. *sabulicola*.

CHAETOCHLOA Scribner (SETARIA Beauv.). In the Kew Bulletin, No. 4, pp. 124–127, 1920, Mr. O. Stapf discusses quite exhaustively the controversy regarding the validity of *Setaria* Beauv. for a genus of grasses as opposed to *Chaetochloa* Scribn. He points out that Acharius in 1798 divided the genus *Lichen* L. into tribes, giving to each tribe a distinctive name and stating that others might consider his tribes as genera. Acharius not only named and described the species under *Lichen*, but appended the new binomial, his tribe name with the specific name, for the benefit of those who might consider his tribes as genera, thus not only publishing his tribes and species under *Lichen*, but also effectively elevating his tribes to genera and making the necessary new combinations thereunder. *Setaria* Acharius is properly published and, being older than *Alectoria* Acharius, is the valid name for that genus of lichens. The next available

[1] For Parts I, II, and III, see Reports of the Michigan Academy of Science, 20: 161–195, 21: 345–371, and 22: 177–185, respectively.

name for the grasses that have been known as *Setaria* is *Chaetochloa* Scribner.

CHAETOCHLOA VERTICILLATA (L.) Scribn. The only locality given for this species of foxtail-grass is my own collection made at Ypsilanti, No. 1187, July 27, 1891. I have since found it at Detroit, No. 1187A, August 13, 1904, and No. 5577½, August 12, 1920. Mr. Billington found in Detroit, in 1919, a form of the species that has very narrow leaves and smaller spikes with fewer and shorter bristles, which may be known as CHAETOCHLOA VERTICILLATA (L.) Scribn., var. **breviseta** (Godr.) n. comb. (*Panicum verticillatum*, var. *brevisetum* Godr., Fl. Lorr., III. 126. 1844, according to Ascherson and Graebner, Syn. Mitt.-Eu. Fl., II. 75. 1899). No. 5570½, August 8, 1920.

The following forms, discussed under Setaria in a previous part of this series, will take the following names under Chaetochloa:

CHAETOCHLOA VIRIDIS (L.) Scribn. var. **major** (Gaud.) n. comb. (*Panicum viride* var. *majus* Gaud., Agrost. Helvet., I. 18. 1811, and Fl. Helv., I. 152. 1828. *Setaria viridis* var. *maior* Koch, Synopsis, 773. 1837).

CHAETOCHLOA VIRIDIS (L.) Scribn. var. **minor** (Koch) n. comb. (*Setaria viridis* var. *minor* Koch, *l.c.; Panicum Weinmanni* R. & S. Syst., II. 490. 1817. *S. viridis* var. *arenosa* Schur. Enum. Pl. Transs., 723. 1866).

CHAETOCHLOA VIRIDIS (L.) Scribn. var. **breviseta** (Doell) n. comb. (*P. viride* var. *brevisetum* Doell, Rhein. Fl., 128. 1843).

CHAETOCHLOA ITALICA (L.) Scribn. f. **praecox** (Alef.) n. comb. (*Pan. Italicum* var. *praecox* Alef., Landw. Fl., 315. 1866. *Panicum Germanicum* Mill. Gard. Dict., No. 1, 1768, according to Hubbard).

CHAETOCHLOA ITALICA (L.) Scribn. var. **Germanica** (Roth) n. comb. (*P. Germanicum* Roth, Tent. Fl. Germ., I. 27. 1788 and II. 71. 1789. *P. Italicum* var. *Germanicum* Koeler., Descr. Gram., 16. 1802. *S. Italica* var. *Germanica* Schrader, Linnaea, XII. 430. 1838.)

CHAETOCHLOA ITALICA var. GERMANICA (Roth) Farwell f.

Metzgeri (Koern.) n. comb. (*P. Italicum* var. *Metzgeri* Koern., Handb. Getreideb., I. 276. 1885).

CHAETOCHLOA ITALICA var. GERMANICA Roth (Farwell) f. **macrochaeta** (Koern.) n. comb. (*P. Germanicum* Willd., Sp. Pl., I. 336. 1797. *P. Italicum* var. *macrochaetum* Koern. *l.c.*).

MUHLENBERGIA RACEMOSA (Mx.) B. S. P., var. VIOLACEA Scribn. Simple stemmed plants with violet or purple spikes. I have not found it except in marl bogs near Orion, No. 4709, October 11, 1917.[2]

MUHLENBERGIA AMBIGUA Torr., var. FILIFORMIS (Muhl.) Farwell. On clay banks at Detroit, No. 5623, August 29, 1920. This species is not listed by Beal.

SPOROBOLUS CRYPTANDRUS (Torr.) A. Gr. In my last number of this series, I described a var. *involutus*, of this species from near Rochester. The typical form of the species was found at Monroe Piers, August 8, 1920, No. 5569. It has flat leaves and an open, spreading panicle, while the variety has the panicle entirely included in the leaf-sheath, the blade of which is involute so that it looks much like some form of rush.

AGROSTIS PERENNANS (Walt.) Tuckerman. Whole plant weak and lax, culms spreading in all directions and lying upon the ground; spikelets $2\frac{1}{2}$–3 mm. long, many of them *articulate below the glumes as in Panicum.* Shady, damp woods, Detroit, No. 5667, August 29, 1920. Another form, more slender, erect and about one-half as long (2–5 dm.) with smaller spikelets ($1\frac{1}{4}$–2 mm.) may be known as **Agrostis perennans** var. **humilis,** n. var. I have not seen the spikelets in any other species of *Agrostis* with articulations below the glumes (not observed in the variety), nor have I seen any mention of such a condition for *Agrostis.*[3] The small, erect form with smaller spikelets may

[2] *M. racemosa* var. *ramosa* (Vasey) Beal. The habit of this plant is much that of *M. Mexicana,* being copiously branched from all or nearly all nodes. Found on Squirrel Island in St. Clair River on the Canadian side of the boundary, No. 5682, September 16, 1920. In all probability it occurs on our side of the line and will be found if looked for.

[3] I have been informed by Mr. Hitchcock that this condition may be observed in any species of *Agrostis,* but that he thinks it is merely a falling away of the glumes. My observations, as stated above, indicate otherwise

be considered as a well-defined variety, but scarcely distinct enough to rank as a good species. Detroit, No. 5672½, August 29, 1920.

Reboulea nitida (Spreng.) Farwell. Listed by Beal (Michigan Flora) as a species of *Eatonia* for which *Reboulea* is the older and valid name. Beal mentions only two localities and records it as *rare*. A third location is the valley of the Rouge, near Franklin, Oakland Co., where it was found in sandy soil on the sides of the bluffs bordering the stream. Billington, Farwell & Walpole, No. 5518, June 24, 1920.

Graphephorum Cooleyi (A. Gr.) n. comb. (*Dupontia Cooleyi* A. Gr. Man., 556. 1852). *G. melicoides* (Mx.) Desv., of which this is usually considered a variety or a synonym, appears to be amply distinct. *G. Cooleyi* has an *acute, awnless* lemma, while *G. melicoides* has a bluntly two-toothed and awned lemma; also the former has hirsute leaves and sheaths, while those of the latter are glabrous. Orion, Oakland Co., No. 882, August 29, 1895. A specimen from Flint in the herbarium of Parke, Davis and Co. is credited without date to the collection of D. Clarke.

Capriola Dactylon (L.) O.K. Beal cites but one locality, Lansing, Mich. Found in a vacant lot on Jefferson Avenue, Detroit, No. 5629, August 29, 1920.

Diplachne fascicularis (Lam.) Beauv. This species was found in August, 1920, in the vicinity of Ypsilanti by Prof. B. A. Walpole. This is a new grass for Michigan; its general range is along the coast from Rhode Island to Texas and inland from Missouri and Nebraska to Mexico. Michigan is, therefore, somewhat out of its usual habitat.

Eragrostis multiflora (Forsk) Aschs. Listed by Beal in Michigan Flora as *E. major* Host. Spikelets oblong, 1 cm. or more in length, 19–41 flowered, very numerous and usually overlapping and forming a very dense, compact, lead-colored panicle. A widely distributed weedy grass. Oxford, Billington, Walpole & Farwell, No. 5609, August 22, 1920. There is another form of this species that looks to be quite distinct, but there are intermediate forms connecting the two. This form

has a very open, somewhat diffuse panicle, shorter (5 mm. or less) spikelets, which are widely separated and only 1/3–1/5 as many, fewer-flowered (5–7, rarely 3–9), and ovate in outline; it is *E. multiflora*, var. *leersioides* (Presl.) Richter (*Poa ciliianensis* All.). Oxford, Billington, Walpole & Farwell, No. 5608, August 22, 1920; Tecumseh, Billington, August, 1920; Detroit, Farwell, No. 5628, August 29, 1920, No. 5628½, August 29, 1920, has the spikelets purplish or purplish-tinged, 3–15 flowered, 3–8 mm. long, some overlapping; evidently an intermediate form, but with more of the characteristics of the variety than of the species.

Korykarpus diandrus (Mx.) O.K. One of the rare grasses in Michigan. Found at Three Oaks, Berrien Co., by Mr. Billington, September 13, 1920.

Uniola latifolia Mx. Not listed by Beal in Michigan Flora. Found by Mr. Billington at Three Oaks, Berrien Co., September 13, 1920. This find not only adds a new species to the flora of Michigan, but also extends the known range of the species considerably northward.

Bromus inermis Leyss. Hungarian Chess. Not included in Gray's Manual; listed by Beal in Michigan Flora as in the vicinity of Lansing. Plentiful along roadsides at Algonac, Billington, Walpole & Farwell, No. 5502, June 20, 1920.

Lepturus incurva (L.) n. comb. (*Aegilops incurva* L. Sp. Pl., 1051; 1753. *Aegilops incurvata* L. Sp. Pl., 1490. 1763. *Lepturus incurvatus* Trin. Fund. Agrost., 123. 1820). Found on waste ground in the manufacturing districts of Detroit, No. 3812½, July 30, 1914. A rare immigrant not since seen.

CYPERACEAE

Cyperus Schweinitzii Torr. This sedge is listed by Beal only for a narrow stretch on the western shores of the State; Manistee is the northern limit and Kalamazoo the eastern. It is found at Monroe Piers on Lake Erie; probably it can be found at intermediate points. Billington & Farwell, No. 4574, September 9, 1917.

SCLERIA TRIGLOMERATA Mx. Royal Oak, Wayne Co., Billington & Walpole, August 4, 1920; Billington & Farwell, No. 5580, August 12, 1920.

SCLERIA CAROLINIANA Willd. In Willdenow's edition of the Species Plantarum, this name has precedence of place over *S. pauciflora* and should be the name used if the two species are to be united. Our plants are of the very pubescent form, typical of the species, which has not before been recorded for Michigan. This find extends the range of the species much farther north. Royal Oak, Billington & Walpole, August 4, 1920; Billington & Farwell, No. 5579, August 12, 1920.

CAREX SCOPARIA Schk., var. CONDENSA Fernald. A form in which all the spikes are narrowly linear due to abortive or unfertilized perigynia. Shores of Lake St. Clair, Algonac, No. 5490, June 20th, 1920. The var. *moniliformis* Tuckerman is an occasional form in which the spikes are separated and the axis flexuous. Port Huron, No. 4975, June 23, 1918. The varieties are rare in comparison with the species.

CAREX STRAMINEA var. FESTUCACEA (Schk.) Tuckerm. Similar to the typical form of the species, but the spikes are clavate at the base from numerous staminate flowers. Collected near Ypsilanti by B. A. Walpole in 1920.

CAREX ALATA Torr. Very local, but its range probably extends throughout the State. Royal Oak, Oakland Co., Billington & Farwell, No. 5578, August 9, 1920.

CAREX ECHINATA Murr. (*C. stellulata* Good.; *C. Leersii* Willd.). A quite variable species. Type form was collected at Ypsilanti, Washtenaw Co., No. 5469, May 30, 1920. Another form with few spikes, more separated and with fewer flowers is var. *ormantha* Fernald; collected at Franklin, Oakland Co., No. 5517, June 24, 1920.

CAREX CEPHALOPHORA Muhl., var. **anomala**, n. var. Peculiar in having secondary inflorescences (either peduncled and in the axils of the leaves or sessile and on the culm 6 or 7 cm. below the terminal head), which are subtended by setaceous bracts often 6 or 7 cm. long; the peduncle from the lowest leaf-axil may be as large and as long as the culm, so that the

plant apparently has twin culms. Dearborn, Wayne Co., No. 5598, August 15, 1920.

CAREX VULPINOIDEA Mx. var. **annectens** (Bicknell) n. comb. (*C. annectens* Bickn. Bull. Torr. Club, 35; 492. 1908). Similar to the var. *ambigua* Barratt, but in this the spikes are subtended by setaceous bracts, the perigynia are sub-orbicular and drab-colored. Equally rare in Michigan. Galesburg, No. 5550, July 20, 1920; Shelbyville, No, 5552½, July 22, 1920.

CAREX SPARGANIOIDES Muhl. var. **lutea,** n. var. Perigynia a bright, golden-yellow. The typical form of the species is an inhabitant of rich woods and is intensely green throughout. This variety is found along roadside ditches and in open fields, is pale or yellowish-green, and the perigynia are bright, golden yellow. Galesburg, No. 5558½, July 20, 1920; Shelbyville, No. 5561, July 22, 1920.

CAREX SCABRATA Schw. Franklin, Billington, Farwell & Walpole, No. 5506, June 24, 1920. Billington found it at Rochester a few days earlier. These stations are farther south than previously recorded.

JUNCACEAE

JUNCUS CANADENSIS L. var. BREVICAUDATUS Engelm. Listed by Beal as for Detroit and for Keweenaw Co. It was found at Marl Lake, Oakland Co., September 18, 1920, by Billington & Farwell, No. 5706; Royal Oak, Oakland Co., Billington & Farwell, No. 5589, August 12, 1920. A rare species preferring open, sandy fields.

JUNCUS TORREYI Coville. The typical form of this species has few (usually 3–6) very large, pale-brownish heads (50–80 flowered, 14–18 mm. in diameter) composing a short (2–3 cm.), simple panicle, terminating a stout stem often 1 m. in height. Belle Isle, Detroit River, No. 1281, Aug. 4, 1892. From this type there are several distinct forms varying to *J. nodosus* L. in the size of heads and slenderness of stems, but retaining the floral characters of *J. Torreyi* Coville, which has larger heads than any other species known to me.

Forma **longipes,** n. f. Differs in having a larger (4–7 cm.)

panicle of more numerous (15–30) greenish heads (20–40 flowered, 10–12 mm. in diameter) on more slender and longer peduncles. River Rouge, No. 4341, July 21, 1916.

Forma **brepipes,** n. f. Similar to the f. *longipes*, but the peduncles or panicle branches are so abbreviated that the glomerules form a dense, often irregular, head. River Rouge, No. 4341½, July 21, 1916.

Var. **paniculata,** n. var. Panicle oblong (16 cm.) with 20–60 or more pale-brown heads (10–30 flowered, 8–10 mm. in diameter). In the small, few-flowered heads, this variety approaches and connects with *J. nodosus*; some of the flowers have the petals equal in length to the sepals as in *J. nodosus*, but lack the long capsule and the brownish-purple color characteristic of that species. Detroit, No. 1648½, July 22, 1899, and No. 1674a, July 6, 1900.

Var. **globularis,** n. var. Stem terminated by a single globular head of 40–80 flowers and 15 mm. in diameter, about 3 dm. in height and slender, as in *J. nodosus*, but the floral characters are those of *J. Torreyi*. Squirrel and Walpole islands in St. Clair River, No. 5689, Sept. 16, 1920.

LILIACEAE

Trillium erectum L., var. album (Mx.) Pursh. A rare form of the species in Michigan. Not often seen. Detroit, Farwell, No. 5434, May 23, 1920.

ORCHIDACEAE

Habenaria hyperborea (L.) R. Br. var. **media** (Rydb.) n. comb. (*Limnorchis media* Rydb. in Britt. Man., 294. 1901). Differs from the typical form of the species in having a more slender, obtuse spur, not clavate-thickened, and manifestly longer than the lip. Doubtless most of this species found in Michigan belong to this variety. Marl Lake near Orion, No. 5707, September 18, 1920. Another variety, much more slender, with smaller, more erect flowers, with spur often acutish, may be known as var. **Huronensis** (Nutt.) n. comb. (*Orchis Huron-*

ensis. Nutt. Gen., II. 189. 1818). Nuttall's species was described from plants collected on the islands of Lake Huron and Lake Michigan. I have seen no specimens of this form from Michigan, though doubtless it is still to be found in the islands just named. Specimens from New York show it to possess good varietal characters. The typical form of the species with clavate spur shorter than the lip probably is not found in Michigan. The variety *media* has the lip somewhat dilated at the base.

TRIORCHIS ROMANZOFFIANUM (Cham.) Nieuwl. Very rare in the southern part of the State. Marl Lake, No. 5701, September 18, 1920.

PERSICARIACEAE

POLYGONUM AMPHIBIUM var. MARGINATUM Farwell, f. **hirtuosum**, n.f. Stems decumbent, 6 dm. or more in length, lowermost nodes occasionally 1 dm. in length and glabrate, the sheaths 1/3 as long, shortened in the upper parts where are overlapping sheaths with broad foliaceous borders; leaves narrowly lanceolate, 13–20 cm. in length, acutish at apex, acute to subcordate at base; peduncles 2–5 cm. hirsute, but not glandular; spike oblong (25 mm. long), dense, flowers a bright rose color, occasionally with a second and much smaller ovoid or subglobose spike; leaves, sheaths and upper parts of stem shaggy with soft, spreading hairs. Detroit, No. 5620, August 29, 1920. Growing on the banks of a drainage ditch which is generally dry. Perhaps this is the same as Greene's *Persicaria villosula.*

AMARANTHACEAE

AMARANTHUS TORREYI (Gray) Benth., f. **prostratus** n.f. Plant prostrate, otherwise as in the typical form of the species. Found by Mr. Billington, September 5, 1920, near the railroad tracks at Tecumseh. The plants were growing on a heap of rubbish which may have been made up of refuse from railroad cars. Mr. Paul C. Standley identified the plant as *A. Torreyi* and writes that previously it has not been reported east of Iowa.

RANUNCULACEAE

ANEMONE QUINQUEFOLIA L., var. **bifolia**, n. var. Involucre composed of but two leaves, about one-half the size of the basal leaf, which is about 12 cm. wide by 6 in length; flower 2.5 cm. in diameter. Under shrubs near Rochester, No. 5431, May 20, 1920.

CRUCIFERACEAE

LEPIDIUM PERFOLIATUM L. Found along the Michigan Central tracks west of Ypsilanti by Prof. B. A. Walpole early in May, 1920.

BURSA BURSA-PASTORIS (L.) Britton, var. 1, INTEGRIFOLIA (DC.) Farwell. Found at Ypsilanti, No. 5466, May 30, 1920. var. 2, **minor** (DC.) n. comb. (*Capsella Bursa-pastoris*, var. *minor* DC. Syst., II. 384. 1821 and Prodr., I. 177. 1824). Plant small, under 3 dm. in height, mostly simple, basal leaves small, under 4 cm. in length. Ypsilanti, No. 5465, May 30, 1920.

CAKILE AMERICANA Nutt. Plants collected on the shores of Lake Erie at Monroe Piers are of this species, according to the classification of Millspaugh, as given in Field Columbian Museum Botanical Series: 2: No. 2. 125–133. 1900.

GROSSULARIACEAE

RIBES OXYACANTHOIDES L. According to the last revision of this species by Fernald, Rhodora, 13: 73–76, 1911, it is confined to the Lake Superior region, so far as its Michigan range is concerned. I have found it in Keweenaw Co., No. 85, May 15, 1884, and No. 3068, August 22, 1912. The plants from other parts of Michigan that have been referred to this species have now been placed in *R. hirtellum* Mx., a name revived for the form with the fruiting canes not bristly above and with leaves without glands, while *R. oxyacanthoides* has been restricted to the form with bristly canes and glandular leaves. Parkedale, No. 3481, June 15, 1913; Rochester, No. 85a, May 25, 1909. The type has the base of the leaves cuneate, while another form with subcordate leaves is var. *saxosum* (Hook.) Fernald. Ypsi-

lanti, No. 5470, May 30, 1920. A third form differs from the type, which is slightly pilose or nearly glabrous, in having the twigs and leaves densely white tomentose and is var. *calcicola*, Fernald. St. Ignace, No. 2052, June, 1908.

LEGUMINACEAE

MEIBOMIA NUDIFLORA (L.) O.K. forma **foliolata**, n. f. An occasional form, found probably throughout the range of the species, with one or two trifoliate leaves on the scape and with or without axillary racemes. Royal Oak, No. 5590, August 12, 1920 (no axillary racemes); Dearborn, No. 5602, August 15, 1920 (axillary racemes).

MEIBOMIA ILLINOENSIS (A. Gr.) O.K. Only three stations given by Beal; a fourth station is Tecumseh, Lenawee Co., where it was collected September 5, 1920, by Mr. Billington.

MEIBOMIA VIRIDIFLORA (L.) O.K. Not listed by Beal, but credited to Michigan in Gray's New Manual. It was found in considerable abundance by Billington & Farwell at Dearborn, No. 5601, August 15, 1920.

PISTACIACEAE

RHUS COPALLINA L. f. **crispa**, n. f. The flowers are transformed into small, variously divided and curled leaves. Detroit, Billington and Farwell, No. 5669, August 29, 1920.

ACERATACEAE

ACER SACCHARUM, Marsh. var. GLAUCUM (Pax) C. S. Sarg. Differs from the type in having the under-side of the leaves glaucous. Algonac, No. 5492, June 20, 1920. Another form, differing from the one mentioned above in having the leaves only 3-lobed and decidedly broader than long, is the var. *Rugelii* (Pax) Rehder, Algonac, No. 5493, June 20, 1920.

CORNICULATACEAE

OENOTHERA MURICATA, L. var. **rubricaulis**, n. var. Fruiting spike very dense, pods strongly overlapping, bracts shorter than

the pods, flowers 1/2-2/3 the size of those of the species, the petals 10 to 12 mm. in length, calyx reddish, stem simple or profusely branched, dark red throughout, leaves more or less red, pubescence as in the species. With the species near Dearborn, where these two forms grow in great abundance, the dense, naked spikes and conspicuously red stems of the variety form a strong contrast to the foliaceous spikes and green stems of the species. Billington & Farwell, No. 5597, August 15, 1920; Detroit, No. 5625, August 29, 1920. Var. *canescens* (T. & G.) Robinson differs from the species in having the pubescens more silky and appressed, the tubercular hairs fewer or absent. Rather scarce, but of wide distribution. Keweenaw Co., No. 2114b, October 7, 1910; Geddes, No. 2114a, August 21, 1909; Stoney Creek, No. 3824, August 9, 1914; Royal Oak, No. 4556, September 8, 1917.

O. PRATENSIS (Small) Robinson. Has sessile capsules and plant is softly hirsute. Detroit, No. 2055, July 8, 1908.

UMBELLATACEAE

URASPERMUM ARISTATUM (Thunb.) var. **villicaule** (Fernald) n. comb. (*Osmorrhiza longistylis*, var. *villicaulis*. Fernald, Rhodora 9: 52-53. 1909). Stem densely white villous. Near Monroe Piers, No. 5476, June 3, 1920. New to the state flora. •

GENTIANACEAE

Gentiana Billingtonii, n. sp. Briefly described as with the habit, stature and foliage of *G. alba.*, var. *Andrewsii*, and with the flowers of *G. puberula*, but with shortened lobes, which are about 4 mm. long and about twice as long as the serrate appendages; the anthers are unconnected. Probably a hybrid of the plants named above. Squirrel Island in St. Clair River on the Canadian side of the line, No. 5678, September 16, 1920. As the anthers are not connected, this would come in the same division of the genus Gentiana as *G. puberula* and should be placed next to it. Though this has not yet been discovered in Michigan, it might be found if looked for where both the species named above are known to occur.

LABIATACEAE

TEUCRIUM OCCIDENTALIS A. Gr., var. **Menthifolium** (Bickn.) n. comb. (*T. Menthifolium*, Bickn.; Britt. Man., 1088. 1907). A slender form with pubescence not viscid nor glandular, flowers smaller. Monroe Piers, No. 5565, August 8, 1920.

T. CANADENSE L. (*T. littorale*, Bickn. Bull. Torr. Club, 28: 169. 1901). Linnaeus writes—"Planta e Canada *Foliis gaudet angustioribus*. . . . *at* Hortensis Foliis majoribus rugosis. . . ." The leaves as thus described represent the plant more recently named *T. littorale*, characterized by narrow, rugose leave. The plant currently passing as *T. Canadense* is *T. Virginicsum*, L., the form with broad thin leaves not rugose, and may be known as *T. Canadense*, var. **Virginicum** (Linn.) n. comb. Monroe Piers, No. 5566, August 8, 1920; Dearborn, No. 5595, August 15, 1920.

DRACOCEPHALUM VIRGINIANUM L. The typical form of this species has narrowly lanceolate, acutely serrate leaves, with the flowers closely set in the spike. Keweenaw Co., No. 621, July 26, 1888. A form with a more paniculate inflorescence, fleshy, broadly lanceolate leaves sharply serrate, and with flowers more closely set in the spike is var. **speciosum** (Sweet) n. comb. (*Physostegia Virginiana*, var. *speciosa*, A. Gray, Syn. Fl., II. 383. 1878). Low wet grounds near Monroe Piers, No. 4566, August 9, 1917.

Another and very different plant has the lower leaves oblong or obovate, obtuse at apex and narrowed into a slender or broadly winged petiole, the upper leaves oblanceolate and acute, not diminishing in size, sessile, all entire or crenate at the apex; the flowers are fewer, usually opposite in the spike, the pairs separated and the bracts smaller and awl-shaped; it is *D. denticulatum*, Ait.[4] Waste grounds at Detroit, No. 5093½, July 14, 1918. Probably an escape from cultivation.

Koellia incana (L.) O.K. Michigan is within the general

[4] The plant described above as *D. denticulatum* is very similar to the illustration in Britton and Brown's Illustrated Flora, Fig. 3600, p. 117. 1913, but the leaves are not reduced. Certainly the illustration of Britton and Brown does not represent the same variety as does Plate 214 of the Botanical Magazine. The former probably represents *D. denticulatum* Ait. var. **obovatum** (Ell) n. comb. (*P. Virginiana*, var. *obovata*, A. Gr., *l.c.*).

range of distribution for this species, but it is not recorded by Beal. I found it on an unimproved lot in Detroit, August 29, 1920; No. 5627.

LYCOPUS LUCIDUS Turcz. (*L. asper*, Greene). Leaves linear-oblong or narrowly oblong-lanceolate, of nearly the same width throughout. Keweenaw Co., No. 1831, August, 1904. The commoner form of this species is var. *Americanus*, A. Gr., in which the leaves are elliptical to lanceolate, or broadest at the middle and narrowed each way. Wyandotte, No. 4384, August 20, 1916.

RINGENTACEAE

Aureolaria heterophylla (Nutt.)[5] n. comb. (*Gerardia heterophylla*, Nutt. Trans. Am. Phil. Soc., 5: 180. 1837). Has large lanceolate, almost foliaceous calyx lobes. Chandler collected this near Orion and a specimen is in the herbarium of Mr. Billington.

DIGITALIS LANATA Ehrh. Some twelve or thirteen years ago, I imported the seeds of a half-dozen or more different species of Digitalis. It was my intention to raise the different kinds and to test them physiologically to ascertain if the other species of Digitalis were as physiologically active as *D. purpurea*, and also to determine if any or all could be used equally well as a therapeutic agent. The seed was distributed to various people who had gardens and were willing to help.

Most of the species were successfully grown, but all died out with their cultivation except *D. lanata* Ehrh. This was grown by Mr. H. C. Hamilton on Grosse Isle, where it has escaped to the roadsides, etc. He informs me that it is very persistent and is spreading. After thirteen years' growth, it prob-

[5] AUREOLARIA SKINNERIANA (Wood) Farwell, var. **asperula** (A. Gr.) n. comb., (*Gerardia tenuifolia*, var. *asperula* A. Gr. Bot. Gaz., 4: 153. 1879.), f. **pallida** n.f. Flowers cream colored. Squirrel Island in St. Clair River, Billington & Farwell, No. 5673, September 16, 1920. Billington collected this at this station a year previously; also at that time, *Aureolaria tenuifolia* (Vahl) Farwell var. **Gattingeri** (Small) n. comb. (*Gerardia Gattingeri*, Small, Fl. So. U. S., 1078. 1903). Billington & Farwell at Squirrel Island, No. 5675, September 16, 1920. *A. tenuifolia* and its allies, as collected on this island, did not turn black in drying and *A. intermedia* did so only partially.

ably should be classed as *adventine*. It has been tested and found to be three times as active as the official *D. purpurea* L. Other species of the genus are likewise therapeutically active.

PLANTAGINACEAE

PLANTAGO RUGELII Dcne. var. **asperula** n. var. Leaves broadly ovate or subrotund, rough pubescent. Billington, Farwell & Walpole; fields near Oxford, No. 5616, August 22, 1920. *P. Rugelii* as found in this region is quite glabrous and the leaves are usually oval.[6]

COMPOSITACEAE

SOLIDAGO BICOLOR var. CONCOLOR T. & G. f. **ramosior** n. f. Plant larger 1 to 1.3 m. in height; racemes of the inflorescence 1 to 3 dm. or more long, forming a panicle that is a quarter or a third of the entire height of the plant. Billington & Farwell, Detroit, No. 5626, August 29, 1920.

S. HUMILIS, Pursh. According to Fernald, Pursh's name belongs to the plant more generally known as *S. uliginosa*. It inhabits bogs and swamps, but is not common. The upper leaves are much reduced; thyrse naked, dense, oblong. Keweenaw Co., No. 579, August 29, 1887; Parkedale, Nos. 3114, 3115, 3117, 3118, September 2, 1912; Marl Lake, No. 5704b, September 18, 1920.

S. UNILIGULATA (DC.) Porter. Similar to the preceding, but the racemes are elongated and recurved, forming a small panicle with the heads one-sided on the branches. Marl Lake, No. 5708, September 18, 1920.

S. NEGLECTA T. & G. has a much larger panicle; the upper leaves are but little reduced and extend into the inflorescence. Orion, No. 930, August 29, 1895; Keweenaw Co., No. 930a, October 8, 1914; Oxford, No. 4763, October 16, 1917; Bloom-

[6] P. RUGELII, var. **alterniflora**, n. var. Leaves small, oval, blade about 4 cm. long on a slender petiole half its length, essentially glabrous; scape 10 cm., the upper half bears about 16 alternate flowers, the lower capsules separated; the upper slightly overlapping. Dr. Asa Fitch, East Greenwich, N.Y., 1861. This and small specimens of *P. major* were distributed by Dr. Fitch as *P. media*.

field, No. 4595, September 16, 1917; Marl Lake, No. 5714½, September 18, 1920. A form of this species when growing with *S. humilis*, and perhaps the result of inter-breeding, has a much reduced panicle; the branches rarely exceed the subtending leaves, many of them not secund. Strongly resembles *S. humilis*, but the inflorescence is longer, looser and foliaceous. It may be known as var. **simulata**, n. var. Marl Lake, No. 5709, September 18, 1920; Oxford, No. 5613, August 22, 1920.

BOLTONIA ASTEROIDES (L.) L'Her. Shores of Huron River and Lake Erie near Monroe Piers, No. 2184, August 20, 1910.

SERICOCARPUS LINIFOLIUS (L.) B. S. P. Keweenaw Co., No. 1829, August 4, 1904.

S. ASTEROIDES (L.) B. S. P., f. **albopapposus** n. f. Pappus white, Galesburg, No. 5097a, August 31, 1918. These two species are north of their recorded ranges and may have been stray immigrants.

ASTER DUMOSUS var. STRICTIOR, T. & G. In this, the fewer branches are more erect and rigid. Marl Lake, No. 5704, September 18, 1920. A form with a simple stem ended by a single head may be known as *Aster dumosus* (L.) f. **monocephalus,** n. f. Marl Lake, No. 5704a, September 18, 1920.

ANTENNARIA BRAINERDII Fernald. Sandy hills and banks of the Huron west of Ypsilanti. No. 5463, May 30, 1920. The plant from Michigan described by Dr. E. L. Greene as *A. bifrons* probably belongs here, but is of much later date.

ERECHTITES HIERACIFOLIA var. INTERMEDIA, Fernald. Upper leaves reduced to bracts. Rare. Detroit, No. 5672, August 29, 1920.

LEONTODON LAEVIGATUM Willd. (*Taraxacum erythrospermum*, Andrz.). The Red-seeded Dandelion. Ypsilanti, No. 5461, May 30, 1920. Previously reported by myself from Detroit. I have seen it on the Keweenaw Peninsula and it probably occurs throughout the State. Frequently the whole herbage dries red.

DEPARTMENT OF BOTANY
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DETROIT, MICHIGAN

THE MYCOLOGICAL FLORA OF THE HIGHER ROCKIES OF COLORADO

C. H. KAUFFMAN

In 1917 the writer, accompanied by his wife, spent the month of August at Leal, Grand County, collecting and studying the fungi of that vicinity.[1] Leal Post-Office is the last ranch at the upper end of the valley through which runs Williams Fork Creek. This station is within the shadow of Ute Peak and of the Williams Fork Mountain range on one side, and the slopes leading to the Continental Divide on the other. At this point the stream is forked, with the two tributaries forming moist, narrow valleys up which much of the collecting was done. The elevations covered varied between 9,000 to 10,000 feet. The surrounding forest is a part of the Arapahoe National Forest. It consists principally of lodge-pole pine, sparsely interspersed with Engelmann spruce, while the higher portions are characterized by thick stands of subalpine fir. Aspen is scattered over the lower openings.

In 1920 a second trip was undertaken, this time to the eastern slope of the Continental Divide, in the region around Tolland, Gilpin County. On this occasion, Mr. Frank B. Cotner and Mr. Dow Vawter Baxter, two students from our laboratory, offered their services, and assisted in a survey of this area during the month of September. Mr. Baxter paid special attention to the rust flora, while Mr. Cotner collected Discomycetes. Unfortunately, Mr. Cotner was called home in the middle of the month, thus reducing the party to two.

A cabin was rented about a mile east of Tolland and excursions made up the streams in all directions. The region is well

[1] A grant of one hundred dollars was given the writer by the American Association for the Advancement of Science, to help defray the expenses of this trip.

known to botanists as the location of the mountain laboratory of the state university of Colorado.

This station was barely twenty-five miles, as the crow flies, from the one at Leal on the west side of the Divide. Its topography and flora have been discussed by a number of writers. (See Literature: 1, 4, 5, 6, 7, 10.)

The forests present and the elevations covered were about the same as at Leal. The rains had been abundant during August, and a copious crop of fungi, especially agarics, had fruited and many of these apparently did not again appear during September. The August crop was still in evidence when the party arrived, but was largely gone before it could be studied. This was especially true of the Cortinarii, which must have been very plentiful in August, but were comparatively rare in September. At Leal, the Cortinarii were astonishingly plentiful in August. In other parts of the United States, no such general fruiting of Cortinarii was observed until later in the season, although fruiting varies more or less with the weather conditions of any season.

Two papers have recently appeared, listing fungi from Colorado. Seaver (8) gives an account of the Discomycetes, many of which were collected at Tolland by Professor Bethel and himself, during August and September, 1910. Overholts (3) spent portions of the two seasons of 1913 and 1914 at Tolland; his lists include all the principal groups of fungi. It was the initial intention of the writer to explore a different portion of Colorado, but circumstances interfered, and Tolland was selected instead. Duplication has, therefore, resulted, but on the other hand, new material was obtained to justify the time spent in this region.

The identifications were made largely by the writer. He is under obligations to Dr. E. B. Mains for an examination of all the Rusts; to C. G. Lloyd for opinions on some specimens sent him; and to Dr. L. O. Overholts for information on the identity of some Porias. The Myxomycetes were identified by May V. Cannon of our Herbarium. In some cases, the writer of this paper has, nevertheless, followed his own judgment, and

all errors of identification should be laid at his door. Many unusual collections were made by those who accompanied us on these trips, and a large share of the success of the ventures is due to them.

The material is or soon will be accessible in the mycological collections of the Herbarium of the University of Michigan.

MYXOMYCETES

From Tolland, Colorado. (See Literature: 2, 9.)

ARCYRIA INCARNATA Pers. On dead wood.
ARCYRIA NUTANS (Bull.). On Merulius.
ARCYRIA OERSTEDTII Rost. On conifer log.
BADHAMIA DECIPIENS. (Curt.) Berk. On bark of spruce.
BADHAMIA MACROCARPA (Ces.) Rost. On dead wood.
COMATRICHA STEMONITIS (Scop.) Sheld. On log.
COMATRICHA SUKSDORFII E. & E. On coniferous log.
DIDYMIUM SQUAMULOSUM (A & S.) Fr. On spruce log.
FULIGO OVATA (Schaeff.) Macbr. On conifer stump.
FULIGO VIOLACEA Pers. On wood.
LEOCARPUS FRAGILIS (Dicks) Rex. On wood of *Populus tremuloides*.
LYCOGALA EPIDENDRON (Buxb.) Fr. On pine log.
MUCILAGO SPONGIOSA (Ley.) Morg. On grasses.
PHYSARUM NEFROIDEUM Rost. On Abies log.
STEMONITIS FUSCA (Roth) Rost. On coniferous log.
TILMADOCHE ALBA (Bull.) Macbr. On old wood.
TRICHIA DECIPIENS (Pers.) Macbr. On log of Picea.
TRICHIA INCONSPICUA Rost. On mossy wood.
TRICHIA PERSIMILIS Karst. On conifer wood.
TRICHIA VARIA (Pers.) Rost. On sticks.
TUBIFERA FERRUGINOSA (Batsch.) Macbr. On dead wood.

ASCOMYCETES

DISCOMYCETES[1]

Geoglossaceae

Cudonia circinans (Pers.) Fr. In moist places under spruce and pine. Tolland.

Mitrula cucullata (Batsch) Fr. Rare, on fallen needles of *Picea Engelmanni.* Tolland.

Mitrula irregularis (Pk.) Durand. Infrequent, Tolland. Low ground under pine and spruce.

Mitrula muscicola P. Henn. Infrequent, Tolland.

One collection on moss at Tolland, 9500-ft. elevation, and one collection on moss in swampy ground at Leal, 8600-ft. elevation, the latter under poplars, the former on a steep, moist mountain side. Seaver (*l.c.*) reports it as *M. gracilis* Karst.

Helvellaceae

Helvella albipes F'k'l. (See Plate XXX.) Frequent, Tolland.

Under Alnus and conifers. It seems best to keep this distinct from *H. elastica*, as the latter is known throughout the Eastern United States. The blackish-brown, bilobed deflexed cap and white to snow-white stem are too striking to be neglected. All our collections except one are, unfortunately, rather immature, but experience with this group indicates that the spore size at maturity would doubtless average well up to the size given for *H. albipes* by Rehm. In one collection the plants are shorter-stemmed, but the spores are more mature and measure up to 21 μ long by 13.5 μ wide.

Helvella infula Fr. (See Plate XXXI.) Leal and Tolland.

Scattered and usually solitary. Aug.–Sept. This cannot as yet be considered as identical with *Gyromitra esculenta* Fr., although Seaver (*Mycologia* Vol. III) has brought together argu-

[1] Discomycetes are noted for the most part according to Rehm, Rabenhorst, *Kryptogamen Flora*, I. 3.

ments in favor of such identity. *Gyromitra esculenta* is a highly gregarious plant, occurring in early spring and nearly always under pines. Its form, to be sure, varies in different individuals and some approach *H. infula* in surface form and lobing. *H. infula*, on the other hand, occurs throughout the summer and fall, in coniferous forests of any kind, singly for the most part, or at least few and scattered in a locality. I have found it, without much variation and not at all suggesting the gyrose cap of the other, in conifer forests from the Atlantic to the Pacific. For the sake of comparison, a photograph of *Gyromitra esculenta*, as it grows abundantly under pines in Michigan, is included. (See Plate XXXII.)

Helvella lacunosa Afzel. form minor. Infrequent, Tolland.

On the ground under conifers. Except for size and a tendency for the stem to be slender and taper upwards, it is not sufficiently distinct. Ascospores 15–17 x 10–12 μ.

Pezizaceae

Acetabula sulcata (Pers.) F'k'l. Somewhat frequent, Tolland.

On moist, sandy, or swampy soil, along streams, etc., under willows, alders, pine and spruce. A very variable plant in size and stem characters, but the ribs scarcely extend into the lower surface of cap. Ascospores 18–23 x 10–13 μ at maturity. The small forms approach *Helvella pezizoides* Afz. The *minor* form of *H. lacunosa*, mentioned above, had very noticeable ribs extending to the margin of the cap.

Geopyxis cupularis (L.) Sacc. Infrequent, Tolland. On the ground under conifers.

Lachnea hirta (Schum.) Gill. Infrequent, Tolland. On wet humus and moss.

Lachnea scutellata Gill. Infrequent, Tolland. On rotten wood. Apothecia over a centimeter broad.

Otidea leporina (Batsch) F'k'l. Infrequent, Tolland. On low ground under conifers. The spores are only 12–13.5 x 7–8 μ, but in other respects, the plants are typical.

Otidea umbrina (Pers.) Bres. Rare, Tolland. On and among moss in low ground under conifers. This is certainly Bresadola's species (See *Fung. Trid.*, II. 68), although our plants were only half-size. Iodine does not color the asci blue. Spores 15–17.5 x 8–9.5 μ.

Plicaria badia (Pers.) F'k'l. Leal and Tolland. On sandy or mossy soil under pine and spruce.

Plicaria repanda (Wahlb.) Rehm. Infrequent, Leal. On very decayed wood and humus, under spruce and pine.

Pustularia coronaria (Jacq.) Rehm. Infrequent, Tolland. Only two collections of one specimen each; apparently, it was too late in the season. Along streams in soil and humus.

Sarcoscypha melastoma (Sow.) Cooke. Rare, Tolland. On much decayed wood imbedded in mossy ground.

Sepultaria arenicola (Lev.) Rehm. Infrequent, Tolland. On sandy soil under pine. Spores 20–24 x 10–13 (14) μ.

Helotiaceae

Chlorosplenium aeruginascens (Nyl.) Karst. On decorticated wood, probably Salix. Well developed apothecia were obtained. The other species was not found.

Coryne urnalis Sacc. Rare, Tolland. On much decayed wood.

Dasychypha pulverulentum (Lib.) Sacc. var. **fructicola** var. nov.

On old fallen cones of *Pinus contorta*. Agrees well with Rehm's description and some European Exsiccati, except in slightly larger average size of the apothecia, which are white externally. Apothecia 1–1.5 (2) mm. broad; asci 55 x 6 μ; spores 7–9 x 1.5–2 μ. The paraphyses are sublanceolate upwards and ally it closely to the genus Lachnum Retz.

Helotium alnicola sp. nov.

Apothecia 1.5–3 mm. broad, 1–4 mm. high, with a pale ochraceous hymenium, later pallid, at first closed, margin incurved on drying, externally white and glabrous, subsessile to stalked, caespitose in small groups on small cankers at base of Alnus trunks recently dead; asci about 225 x 10–12 μ, cylin-

drical, rounded above; paraphyses hyaline, filiform, non-clavate above, 3–4 μ diam.; ascospores 20–25 x 5.5–6.5 μ, subfusiform, smooth, minutely granular within or with one central oil-globule; none were seen septate.

On small cankers at base of dead trunks of *Alnus tenuifolia*, along streams, frequent. Whether this acts parasitically could not be determined, but some of the circumstantial evidence obtained seemed to indicate that it does.

HELOTIUM BOUDIERI Sacc. et Trott. On bark and wood of *Alnus tenuifolia*. When fresh, the apothecia are cream-buff, which changes to fulvous-yellow on drying and with age.

HELOTIUM CITRINUM (Hedw.) Fr. Common, Tolland. On rotten wood of deciduous trees.

HELOTIUM SULPHURATUM (Schum.) Phil. var. **Piceae** var. nov.

Gregarious on decaying needles of *Picea Engelmanni*. Apothecia 1–3.5 mm. broad, disk pale-yellowish, glabrous externally, on short, thick, darker stipe; asci cylindrical, about 150 x 12 μ, paraphyses equal, filamentous, straight or frequently somewhat coiled above, projecting above asci; spores hyaline, smooth, continuous, without oil-drop, 10–12 x 5–6 μ. This probably deserves more than varietal rank.

HYMENOSCYPHA SCUTULA (Pers.) Phillips. var. **Grossulariae,** var. nov.

Apothecia 1–3 mm. broad, slightly tough, externally white and minutely tomentulose, disk when fresh "antimony yellow" (Ridg.), stipe short, 1–2 mm. long, slender, "cinnamon" (Ridg.). Asci 100–110 x 8–9 μ, subcylindrical, slightly thick-walled not blue with iodine; ascospores 16–19 x 3–4 μ, hyaline, 1-septate at the last, subfusiform, more acute at one end, paraphyses filamentous, equal throughout in width.

On dead stems of Grossularia sp. 9500-ft. elevation. There are no definite hairs externally, such as occur in apothecia of Dasychypha.

HYMENOSCYPHA SUBLENTICULARE var. CONSCRIPTUM Karst. On decaying wood of Salix. Disk dingy pale-ochraceous. Ascospores 14–16 x 4–4.5 (5) μ.

HYMENOSCYPHA VIRGULTORUM Phill. On old wood, probably

of Alnus. Apothecia chrome-yellow when fresh, then dull red. Spores 12–18 x 3.5–4.5 μ.

LACHNELLULA CHRYSOPHTHALMA (Pers.) Phillips. On timbers of coniferous wood in interior of mines. See note by Seaver (*l.c.*).

LACHNELLA FLAMMEA (A. & S.) Fr. Common, Tolland. On decorticated sticks of Salix sp., *Alnus tenuifolia*, and *Populus tremuloides*.

LACHNUM BICOLOR (Bull.) Karst. Infrequent, Tolland. On decayed log of Salix. Disk of apothecium yellow when fresh, fading.

OMBROPHILA JANTHINA (Karst.) Rehm. Infrequent, Tolland. On decaying cones and cone debris of *Picea Engelmanni*.

PHIALEA LUTESCENS (Hedw.) Gill. Infrequent, Tolland. On rotten hard wood of conifers.

PHIALEA SUBTILIS (Fr.) Rehm. Frequent locally.

On needles of *Picea Engelmanni* in brush-piles, partly covered by debris from high water. The slender stipes are longer than are typical in the sense of Rehm, being 0.5–2.5 mm. long, and the spores are very narrow, scarcely over .5 μ wide. The plant is entirely pure white when fresh.

TAPESIA EVILESCENS Karst.

Apothecia .5–1 mm. broad, cupulate when fresh and then disk is whitish, cinerescent, externally with whitish margin, elsewhere brownish-fuscous, glabrous except where immersed at base in the fuscous, adnate, rather thin, interwoven subiculum; context thin, whitish above, brownish-filamentose downward, with a thin excipulum of subpolygonal, dark brown and thick-walled cells; asci 50–65 x 3–4 μ, subcylindric–subfusiform, subacute at apex; paraphyses filiform, equal, 1–1.5 μ thick, hyaline. Spores cylindrical, straight, subequal, 8–9 (10) x .5–1 μ, biseriate in upper part of ascus. Hyphae of subiculum dark brown, brittle, thick-walled, septate, 3–3.5 μ diam.

Closely gregarious on subiculum, on decorticated fallen branches of *Alnus tenuifolia*. Tolland. Elevation 9000 ft.

Although *T. evilescens* is reported on dead stems of Graminaceae, this species is closely allied to it, by its very narrow spores, and by this character is removed from the

ordinary wood-inhabiting species. On drying, the margins of the apothecia become incurved and remain whitish; elsewhere the apothecia become blackish-cinereous.

Mollisiaceae

Mollisia cinerea (Batsch.) Karst. Common, Tolland. On old logs, etc., of Salix, etc.

Mollisia melaleuca (Fr.) Sacc. Rare, Tolland. On decayed wood of *Alnus tenuifolia*.

Mollisia trabincola Rehm. Rare, Tolland.

This curious species dries up and is hard to find unless the substratum is moistened. It gives the appearance when wet of belonging to the Stictidaceae, and on drying takes on an elongated form at times. Spores 6–8 x 1.5–3 μ. Iodine does not affect the asci.

Cenangiaceae

Cenangium abietis (Pers.) Rehm. Infrequently seen, Tolland. On dead twigs of *Pinus contorta*.

Cenangium alpinum E. & E. Common, Tolland and Leal.

On dead branches of *Picea Engelmanni* and *Pinus contorta*, 9000-ft. elevation. Although no authentic material was examined, the plant is unique by the fimbriate margin of the apothecia, which are folded lengthwise and measure 1–2.5 mm. along the incurved fold. The fimbriate condition is due to dark yellow-brown hairs about 100–120 μ long, 4–5 μ thick, septate, hyaline toward apex and minutely granular. The apothecia occur singly or in groups of few individuals. The asci measure 45–55 x 5–6 μ. The paraphyses are filiform and equal. The spores in the specimens examined averaged slightly different from those given by Ellis, being 8–12 x 2.5–4 μ in size.

Godronia Betheli Seaver. Common, Tolland. On dead branches of *Alnus tenuifolia*.

Stictidaceae

Ocellaria aurea Tul. Frequent, Tolland. On dead branches of Salix sp.

PROPOLIDIUM AMBIGUUM Starb.

On old, decorticated wood of some deciduous tree. This interesting fungus was obtained in too small quantity for one to be sure of its identity. However, the negative iodine test, the pale ochraceous to fulvous-tinged disk, as well as the spores and asci agree so well with this ambiguous species, that it may probably be it.

PROPOLIS FAGINEA (Schrad.) Karst. Infrequent and in old condition. On wood. Tolland.

TRYBLIDIACEAE

ODONTOTREMA MINUS Nyl. Form **salicella** forma nov.

On sticks of Salix sp. Differs apparently only in its host. Asci measure 30–40 x 7–9 μ, spores 9–11 x 3.5 μ, fusoid, 1–3 septate, hyaline. Paraphyses rarely branched at apex and not enlarged above.

HYPODERMATACEAE

LOPHODERMIUM ARUNDINACEUM (Schrad.) Chev. forma *apiculatum* (Fr.) Duby.

LOPHODERMIUM PINASTRI (Schrad.) Chev. Tolland.

Causing yellowing of young trees of *Pinus contorta*, especially along wet places, with accompanying leaf-cast. Effect was seen only in scattered places.

HYSTERIACEAE

LOPHIUM DOLABRIFORME Walbr. Common, Tolland.

On sticks of Salix in wet situations. (See *Mycologia*, XII., 180. 1920.) Patouillard's Fig., No. 294, *Tab. Analyt.*, and his description under *L. elatum* Grev., seem to me to refer to the same species.

PYRENOMYCETES

HYPOCREALES

NECTRIA SANGUINEA Fr. Common, Tolland. On an old valsaceous stroma; on Salix.

DOTHIDEALES

Phyllachora trifolii (Pers.) Fkl. Tolland. On *Trifolium repens*. Associated with it is *Polythrincium trifolii* Kze. and a Phyllosticta.

PERISPORIALES

Sphoerotheca humuli var. fuliginea (Schlecht.) Salmon. On Castilleja sp. Tolland.

SPHAERIALES

Bertia moriformis (Tode.) De Not. Tolland. On decaying log of poplar or alder.

Cryptosphaeria vicinula (Nyl.) Karst. Tolland. On dead branches of *Alnus tenuifolia*. Easily recognized from Saccardo's description. The spores are quite brown at maturity, being 11–15 x 3–3.5 μ.

Diaporthe nivosa Ell. & Holw. Tolland.

On branch of *Alnus tenuifolia*. This is in much better condition than Ellis's specimens distributed in *N. A. F.*, which is somewhat immature. The spores are given too small in Ellis, *N. A. Pyren.*, p. 436, as shown both by an examination of our copy of Ellis's No. 2535, and by the present collection. The ascospores are 16–19 x 5–5.5 μ, oblong-subfusoid, pointed at ends, 1-septate, hyaline.

Diatrypella discoidea var. alni Cke. Frequent, Tolland. On dead branches of *Alnus tenuifolia*.

Eutypella alnifraga (Wahl.) Fr. Tolland. On dead branches of *Alnus tenuifolia*.

Hypoxylon Morsei B. & C. Tolland. On dead branches of *Alnus tenuifolia*. The spores in old perithecia run up to 27 μ in length, but ordinarily they are 19–24 x 8–9 (10) μ. Single perithecia are often 1.5 mm. in diameter, or even larger.

Lophiostoma macrostomoides (De Not.) Ces. & De Not. Tolland. On decorticated sticks of Alnus or poplar. This species blackens the surface of the wood.

Lophiotrema hysterioides Ell. & Langlois. Tolland. On decorticated wood of poplar or willow. As I did not have

access to a specimen of this, my identification is based entirely on the description with which it agrees well.

Rosellinia albolanata E. & E. Tolland.

On decorticated sticks of Salix. Ascospores 25–27 x 5–8 μ. In the early condition it has a thin "cartridge-buff" (Ridg.) subiculum which extends considerably beyond the fertile portion, much as in *R. subiculata*. The perithecia are for quite a time covered by it, but gradually denuded as they approach maturity. In age, the subiculum becomes "ecru-drab" to cinerescent. Ellis, in *N. A. Pyrenomycetes*, places it in the wrong section.

Rosellinia thelena Rabenh. Rare, Tolland. On dead bark of *Picea Engelmanni*. Known by the distinct appendages at each end of spore.

Strickeria megastega (E. & E.) comb. nov. Tolland. (*Teichospora megastega* E. & E., *Proc. Acad. Nat. Sci.*, Phila., 1890, p. 243.) Common, Tolland. On decorticated sticks of Salix, Alnus and poplars.

Trematosphaeria corticola Fkl. Tolland.

On decorticated wood of *Alnus tenuifolia*. The perithecia at first break through, but at length appear entirely superficial; the asci have very thick walls; the spores measure 35–40 x 7.5 μ.

Valsa abietis Fr. Tolland. On dead branches of *Abies lasiocarpa*.

Valsa nivea Fr. Tolland. On dead branches of *Populus tremuloides*. The material is overripe and few spores were seen. Associated with *Cytospora nivea*. Ascospores 9–12 x 1.5–2 μ.

Valsa salicina (Pers.) Fr. Tolland. On dead branches of Salix.

Valsa sordida Nitschke. Tolland. On dead branches of *Populus tremuloides*.

Valsaria moroides (C. & P.) Sacc. Tolland. On dead branches of *Alnus tenuifolia*.

BASIDIOMYCETES

UREDINALES

AECIDIUM ASTERUM Schw. Infrequent. Tolland. On Aster sp.

CALYPTROSPORA COLUMNARIS (A. & S.) Kühn. On *Vaccinium oreophilum* Rydb. Common, Tolland. Leal.

COLEOSPORIUM SOLIDAGINIS (Schw.) Thüm. On Solidago. Common. Tolland. Leal.

GYMNOSPORANGIUM JUNIPERINUM (L.) Mart. On *Sorbus scopulina*. Infrequent. Tolland.

MELAMPSORA ALBERTENSIS Arth. On *Populus tremuloides*. Common, Tolland.

MELAMPSORA BIGLOWII Thüm. On Salix sp. Common. Tolland.

MELAMPSOROPSIS PYROLAE (D. C.) Arth. On *Pyrola secunda*. Frequent, Leal, Tolland.

PERIDERMIUM COLORADENSE (Diet.) Arth. & Kern. Forming witches brooms on *Picea Engelmanni*. Frequent. Leal and Tolland.

PERIDERMIUM COLUMNARE (A. & S.) Kunz. & Schum. On needles of *Abies lasiocarpa*. Frequent. Tolland.

PERIDERMIUM CONORUM-PICEA (Rees) Arth. & Kern. On cones of *Picea Engelmanni*. Common, Tolland.

PERIDERMIUM FILAMENTOSUM PK. On branches of *Pinus contorta*, scarcely hypertrophied. Leal, infrequent.

PHRAGMIDIUM MONTIVAGUM Arth. On leaves of Rosa sp. Common, Tolland.

PHRAGMIDIUM SPECIOSUM Fr. On *Rosa melina*. Infrequent. Leal.

PUCCINIA ATROPUNCTA Pk. & Clint. On *Veratrum speciosum*. Leal.

PUCCINIA CIRSII Lasch. On *Cirsium griseum*. Infrequent, Tolland. On *Carduus Hookerianus*. Infrequent, Leal.

PUCCINIA CLEMATIDIS (D C) Lagerh. (I) On Thalictrum sp. Tolland.

PUCCINIA CLINTONI Pk. On Pedicularis. sp. Frequent. Tolland.

Puccinia Heucherae (Schw.) Diet. On *Heuchera Hallii.* Tolland.

Puccinia monoica Arth. (I) On Arabis sp. Leal.

Puccinia patruelis Arth. (I) On *Agoseris glauca.* Leal.

Puccinia Pimpinellae (Str.) Lk. On Osmorhiza sp. Tolland.

Puccinia polygoni-vivipari Dietr. On *Polygonum bistortoides.* Leal.

Puccinia taraxici (Reb.) Plow. On *Taraxacum officinale.* Frequent, Leal and Tolland.

Puccinia Troximontis Pk. II, III. On *Agoseris glauca.* Leal.

Pucciniastrum Myrtilli (Schum.) Arth. On Vaccinium sp. Infrequent, Leal and Tolland.

Pucciniastrum pustulatum (Pers.) Diet. On *Epilobium adenocaulon.* Infrequent, Tolland.

Pucciniastrum Pyrolae (Pers.) Diet. On *Pyrola secunda.* Infrequent, Leal, Tolland.

Uromyces Trifolii Lev. On *Trifolium repens.* Frequent. Leal, Tolland.

Uropyxis sanguinea (Pk.) Arth. On *Berberis aquifolium.* Rare. Tolland.

TREMELLALES

Dacryomcetaceae

Guepinia monticola Tracy & Earle. Rare. Tolland. On bark of *Picea Engelmanni.*

Auriculariaceae

Auricularia auricula-judae L. Frequent, Leal and Tolland. On logs and branches of Abies, etc.

Tremellaceae

Exidia glandulosa Fr. Common. Tolland, Leal. On Salix branches etc.

Hormomyces fragiformis Cke. Infrequent. Tolland, Leal. On old logs.

Tremellodon gelatinosum (Scop.) Schroet. Rare. Leal. On wet logs under Abies.

AGARICALES

Thelephoraceae

Coniophora byssoidea Fr. Sept. Rare. Tolland. On fallen decaying trunk of *Abies lasiocarpa*.

Coniophora olivacea (Fr.) Karst. Sept. Infrequent. Tolland. On coniferous log.

Coniophora polyporoidea (B. & C.) Burt. Sept. Rare. Tolland. Hanging, loosely attached, over mossy rocks along stream.

Corticium albulum Atk. & Burt. Rare. Tolland. On much decayed wood of pine and spruce.

Corticium galactinum (Fr.) Burt. Sept. Tolland. On log of *Abies lasiocarpa*.

Corticium investiens (Schw.) Bres. Infrequent. Tolland. On much-decayed wood of pine or spruce.

Hymenochaete tabacina Fr. Sept. Infrequent. Leal. Tolland. On dead fallen branches of Salix.

Peniophora Allescheri Bres. Sept. Tolland. On log of *Abies lasiocarpa*.

Stereum abietinum Pers. Rare. Tolland. On coniferous log.

Stereum purpureum Fr. Sept. Rare. Tolland. On Salix.

Stereum rameale Schw. Sept. Common. Tolland. On dead Alnus.

Stereum rufum Fr. (*Corticium pezizoideum* (Schw.) Schrenk.). Sept. Frequent. Tolland. On *Populus tremuloides*.

Stereum rugispora (E. & E.) Burt. Sept. Infrequent. Tolland. On logs of *Picea Engelmanni*.

Stereum sanguinolentum Fr. Sept. Rare. Tolland. On bark of a log of *Picea Engelmanni*.

Stereum sulcatum Burt. Sept. Rare. Tolland. On coniferous log.

Thelephora caryophyllea Fr. Frequent. Tolland. On the ground under conifers.

Hydnaceae

Hydnum aurantiacum Pk. Sept. Infrequent. Tolland, Leal. Under Abies.

Hydnum imbricatum Fr. Infrequent. Leal.

Under pine and spruce. This agrees well both microscopically and macroscopically with material I obtained near Stockholm, Sweden. It is futile to refer this species to Linnaeus. We have, therefore, the northern European plant in this country. It is necessary, however, to use the highest magnifications in examining the spores and basidia in order safely to segregate the species which are somewhat similar externally, and to possess good field-notes.

Hydnum graveolens Dolastre var. Sept. Rare. Tolland. Under conifers (pine and spruce).

Hydnum repandum Fr. Sept. Infrequent. Tolland, Leal. Under conifers (pine and spruce).

Hydnum scrobiculatum Fr. Sept. Infrequent. Tolland. Under conifers (pine and spruce).

Hydnum suaveolens Fr. (See Plate XXXIII.) Sept. Infrequent. Tolland. Under conifers (pine and spruce).

Hydnum Underwoodii (Banker) Coker. Sept. Frequent. Leal, Tolland.

Under spruce and fir. Three collections were brought. Its superficial characters were not sufficiently striking in the older and larger plants to indicate that we had something interesting and doubtless we usually passed it by as *H. imbricatum*. When it is younger and smaller in size, the teeth are short and the description of Banker and Coker applies well. When it is larger and more luxuriantly developed, the teeth are as much as 5 or 6 mm. long, and the surface of the pileus may become cracked-scaly and imitate *H. imbricatum*. But the crowded, slender and fragile teeth, and, to a smaller degree, the color of the plant, separate it quickly from *H. imbricatum*. Our larger specimens compare well with Ellis, *N. A. F.*, No. 926 (*H. imbricatum*), and although Banker included this in his account of *H. Underwoodii* (*Mem. Torr. Bot. Club*, XII: 148. 1906), his formal

description does not take into account the longer teeth of Ellis' specimens. Our smaller specimens, although possessing mature spores, are evidently not full size and are well indicated by Coker's illustrations of the species. (*Jour. Elisha Mitchell Sci. Soc.*, 34: Plate 7, facing p. 172. 1919.)

ODONTIA SETIGERA Fr. Sept. Infrequent. Tolland. On coniferous wood.

PHLEBIA ALBIDA Fr. Sept. Rare. Tolland. On log of *Abies lasiocarpa*.

BOLETACEAE

BOLETUS AMERICANUS Pk. Under spruce and pine. Tolland.

BOLETUS PUNCTIPES Pk.

Under spruce and pine. Tolland. This species which some have included with *B. granulatus* Fr., was very abundant and is entirely the Peck conception. Only in age or when dried, does it show the characteristics of its sister species. Typical *B. granulatus* was not seen.

BOLETUS SCABER Fr. Under spruce and pine.

Boletus tomentosus sp. nov.

Pileus 5–8 cm. broad, convex-subexpanded, obtuse, dry, becoming subviscid in wet weather, ground color "antimony yellow" (Ridg.), covered with "yellow-ochre" to "buckthorn brown" *tomentose*, rather small *scales*, which are disposed in an areolate manner; flesh *white, changing slowly to "pale sky-blue"* (Ridg.), amber-yellow under the cuticle. Tubes depressed around stem, *almost free*, convex, 4–6 mm. long, 1–2 to a mm., angular, radiately subelongate, "yellow-ochre" at first, soon changing to "tawny-olive" or "buckthorn-brown," dissepiments thick; mouths concolor, uneven. Stem 3–5 cm. long, 1.5–2 cm. thick, solid soon cavernous or grubby, subcompressed, even, obscurely subtomentose, "amber-yellow," dotted by scattered, minute, reddish-brown points; flesh white changing to pale sky-blue. Spores narrowly subfusiform, 8–9 x 3 μ, subhyaline or scarcely tinged straw color. Taste mild. Odor slight.

Under fir and pine. Leal and Tolland, Colorado, Aug.–Sept.

This is doubtless the plant referred to *B. hirtellus* Pk. by Overholts. If it is that species, the descriptions of it so far pub-

lished must be considerably emended. *B. tomentosus* has characters showing it to be intermediate between the "gyroporus" group and the "Roskovites" group. The flesh of the stem tends to break down as in *B. castaneus* and the pileus is not truly viscid. On the other hand, the tubes are almost free from the stem and do not blacken on drying. The colors are not golden as given by Peck for *B. hirtellus;* the flesh changes to sky-blue and the spores are almost hyaline.

Boletus versipellis Fr. Under poplars. Common. Leal. Tolland. It is surprising that this was not reported by Overholts. It has some similarity to *B. scaber*, and may have been confused with it.

Polyporaceae

Fomes applanatus Fr. September. Tolland. Rare. On *Populus tremuloides.*

Fomes igniarius Fr. (Poplar form). Sept. Infrequent. Tolland. On living trunk of *Populus tremuloides.*

Fomes pinicola Fr. September. Leal, Tolland. Frequent. On *Pinus contorta.*

Fomes roseus Fr. Sept. Rare. Tolland. On logs of *Picea Engelmanni.*

Irpex deformis Fr. Sept. Rare. Tolland. On log of *Pinus contorta.* Unusual in its occurrence on coniferous wood.

Irpex fuscoviolaceus Fr. (f. resupinata). Sept. Infrequent. Tolland. On log of *Pinus contorta.* (See Overholts, *Ann. Mo. Bot. Gard.*, 22. 686. 1915.)

Lenzites abietinellus (Murr.) Sacc. Sept. Rare. Tolland. On dead Alnus branches.

Lenzites sepiaria Fr. Sept. Common. Leal. Tolland. On old or charred logs of *Pinus contorta.* There are no good intermediate forms between this and *Trametes protracta* when observed in their development in this region.

Merulius gyrosa Burt. Sept. Rare. Tolland. On coniferous wood.

Merulius sororia Burt. Sept. Rare. Tolland. On coniferous wood.

Polyporus alboluteus E. & E. Sept. Infrequent. Tolland. On mine timbers of coniferous wood.

Polyporus caesius Fr. Sept. Infrequent. Tolland. On very rotten coniferous wood.

Polyporus cinnamomeus Fr. Sept. Frequent. Leal. Tolland. On low or sandy ground under pine and poplar, etc.

Polyporus circinatus Fr. Sept. Frequent. Leal. Tolland. Under spruce and fir.

Polyporus confluens Fr. (See Plate XXXIV.)

(*A*) Tolland. Sept. Common, but scattered-gregarious. About a dozen collections were made on succeeding days; special attention was paid to get the possible variations due to age, habit, color, amount of stem-confluence, etc. Although occurring in widely scattered localities on the slopes of the ranges under lodge-pole pine and Engelmann spruce, a day's trip would yield easily a peck or more. A large amount was thus obtained and the facts noted. It seems desirable to record this study in the following description.

Pilei fleshy, firm, somewhat fragile, either simple and then up to 10 cm. broad, or on branching stems with few pilei, or on confluent to connate stems with several pilei 5–10 cm. broad, orbicular, eccentric or irregularly compressed, sometimes wavy-lobed, convex, obtuse; surface dull white when perfectly fresh, i.e., "ivory-white" (Ridg.), soon "cinnamon-buff" to "clay-color" (Ridg.) when rubbed, in age, or after being exposed to wind or sun, provided with a more or less differentiated cuticle which becomes either minutely rimose, areolate-rimose, or diffracted-scaly according to weather conditions, showing whitish context between the cracks, glabrous; margin thin almost membranous, persistently incurved, substerile to fertile. Context when fresh quite thick, 1–3 cm.+ in thickness, white, fleshy, homogeneous, compact but rather soft when fresh, fragile, but becoming harder and firm in dry weather, slowly assuming a "cinnamon-buff" color when broken or attacked by larvae.

Hymenophore composed of very short tubes, 1–2 mm. long, varying subdecurrent to long-decurrent and somewhat oblique from the oblique position of most stems; mouths not at first

stuffed, white, but soon "straw-yellow" (Ridg.) or lutescent, 2–3 to a millimeter, at first angular with thick dissepiments which become thin and lacerate-serrate or frequently break down in age so as to yield pores of larger size.

Stem 4–10 cm. long, ventricose-irregular, pointed at base, single, subconfluent or confluent-connate, often compressed or subsulcate, frequently irregular and ascending, sometimes covered above for half the length with abortive pores, white when fresh, becoming "cinnamon-buff" or lutescent when handled or in age, covered with a thin floccosity, flesh spongy and white at first, then compact and sublutescent. Cystidia none. Spores minute, oval, smooth, hyaline, apiculate, 4–5.5 x 3.5–4 μ, usually with an oil-drop. Odor slight and then pleasant, or none. Taste mild.

The herbarium specimens of these collections, now a little over a year in the dried condition, scarcely show tendencies to take on a tinge of reddish. The pilei and stems are now generally sordid "cinnamon-buff, clay-color to tawny-olive" (Ridg.), verging here and there into "pecan-brown" where the rufescent tendency occurs, while the pores vary between "buffy-brown" and "mikado-brown," the extremes matching poorly. My collections from Elkmont, Tenn., also under pines, which I referred to *P. confluens*, although colored when fresh like the Colorado plants, show now, after five years in the herbarium, their rufescent character strongly. Indeed, the Colorado plants might perhaps be confused with *P. ovinus* in the dried condition.

P. ovinus, however, becomes, when dried, blackish-stained as if scorched, and the tubes are not strongly decurrent, the plants are more regular and more truly white when fresh, and the stems are simple. The tubes of the dried specimens of individuals of *P. confluens*, which were picked in a fresh growing condition, have a paler, a pinkish-buff color, while those specimens which had matured and were slightly weathered when picked, have the tubes now as described above.

A comparison of the figures by Fries (*Sverig ätl Svamp.*, Pl. 24) and by Barla (Pl. 29, Figs. 2 and 3) shows that the habit of the Colorado plants is much less complex; the majority have

few branches or a small number of confluent stems. Only occasional plants possess the large number of pilei shown in these figures. The color in the figures cited cannot be taken too seriously, in view of the variations in the plants of the terrestrial group to which *P. confluens* belongs. I have no doubt that the Tennessee plants are the true *P. confluens*, and although the Colorado plants do not match at all at present, I think they must be considered the same thing.

(*B*) Leal. Aug. Rare.

These collections were at first referred to *P. confluens*, but further study makes this reference doubtful. Only one collection was made. The tubes when dried are "Saccardo's umber" to "sepia," very regular even in the mature plant, angular, and the mouths do not become lacerate-dentate. Stems simple or sparsely branched, distinctly "orange-rufous" (Ridg.), probably with an orange-rufous mycelium. The pileus is rather thin, with a membranous incurved margin, whitish-lutescent when fresh, glabrous, and with a cuticle; the pileus dries much thinner than those under (*A*). Spores, etc., like *P. confluens*.

It is not unlikely that this is the long-lost *Polyporus politus* Fr. It is true the pileus does not show the red color except as a tint. In *Icones*, Fries states that his figures were made from dried specimens, and doubtless the drawings were somewhat conventionalized. On the other hand, it would be easy to see in Fries's figure of *Polyporus subsquamosus* our diffracted-scaly specimens of *P. confluens* described above.

As to *P. fractipes* Murr. and *P. peckianus* Sacc., one cannot be very positive. A specimen of what is apparently a good *P. peckianus* is in my herbarium; it differs at once from the Colorado species by its smaller pores, and according to Peck's original description, as *P. flavidus* (*N. Y. Mus. Rep.*, 26: 68), the pileus is depressed-funnel form, and its pores are yellow, while according to Lloyd (Vol. V., letter 62, note 429), its spores are smaller, 3.5 x 2.5 μ. *P. fractipes* Murr. is said to have small pores also, 4–5 to a mm., and the pileus is much thinner than that of the Colorado plants; other characters agree rather well with form (*A*). There remains *P. Whitei* (Murr.).

This is only separable from the Colorado form (*A*), following Murrill's description, by the rose color which the tubes and flesh assume on bruising or drying, unless the character of a pruinose pileus be important.

Polyporus elegans Fr. Sept. Infrequent. Leal. Tolland. (*Polyporus varius*.) On dead branches of *Populus tremuloides*.

Polyporus fragilis Fr. Sept. Rare. Tolland. On coniferous log. Spores 4–5 x 1.5 μ.

Polyporus hirtus Fr. Rare. Leal. On old stump of *Pinus contorta*.

Polyporus leucospongia Ell. & Hark. Sept. Frequent. Leal. Tolland. On old or charred logs of *Pinus contorta* in forest burns where logs are under dry conditions.

Polyporus osseus Fr. Rare. Leal. At base of living trunk of *Picea Engelmanni* on the exposed dead part of a root.

Polyporus perennis Fr. Sept. Infrequent. Tolland. On the ground under conifers.

Polyporus resinosus Fr. Sept. Apparently rare. (*P. benzoinus*, sense Lloyd.) On *Abies lasiocarpa*. In good condition with surface of pileus hispid-reticulate, with metallic-bluish zones.

Polyporus ursinus Lloyd. Sept. Infrequent. Tolland. Leal. On old logs of pine and fir. Spores 8–10 x 2.5–3.5 μ. Hymenium provided with short hyaline cystidia, often encrusted at apex.

Polystictus abietinus Fr. Sept. Frequent. Leal. Tolland. On logs, etc., of pine, Abies and spruce.

Polystictus subchartaceus Murr. Sept. Infrequent. Tolland. On dead *Populus tremuloides*.

Poria medullae-panis Fr. Sept. Frequent. Tolland. On coniferous logs.

Poria obducens Fr. Sept. Tolland. On coniferous log.

Poria salmonicolor B. & C. Sept. Rare. Tolland. On coniferous wood.

Trametes carnea Nees. Sept. Tolland. Infrequent. On bark of *Pinus contorta* and *Picea Engelmanni*.

TRAMETES MOLLIS Fr. Sept. Frequent. Tolland. On log of *Abies lasiocarpa*. Reported only on deciduous trees by Overholts.

TRAMETES PICEINA Pk. Sept. Infrequent. Tolland.

Forming low, narrow, strips on decorticated fallen logs of Picea. Markedly distinct from the *Trametes pini* fruit-bodies on the same host and in same region, by its smaller pores and its resupinate-reflexed habit. (See, however, Overholts, *Ann. Mo. Bot. Gard.*, 22: 722. 1915.)

TRAMETES PINI Fr. Sept. Very common. Leal. Tolland. On *Pinus contorta*, *Picea Engelmanni*, *Abies lasiocarpa*. On living or dead trunks. Large percentage of pines had heart rot.

TRAMETES PROTRACTA Fr. Sept. Common. Leal. Tolland. Common on old and charred logs of *Pinus contorta*. This is distinct from *T. vialis* Pk.

TRAMETES SERIALIS Fr. Sept. Rare. Tolland. On dead branches of Salix sp.

TRAMETES TENUIS Karst. Sept. Frequent. Leal. Tolland. fide Overholts. On charred logs of *Abies lasiocarpa*, forming extensive patches up to 20 cm. long.

TRAMETES VARIIFORMIS Pk. Sept. Frequent. Tolland. Leal. On coniferous wood.

CLAVARIACEAE

CLAVARIA AUREA Fr. Infrequent. Tolland, Leal.

On the ground under pine, spruce and fir. Spores subhyaline, 9–12 x 4–4.5 μ, rarely up to 15 μ long. Size and habit similar to *C. flava*. Color of branches "apricot-yellow" to "buff-yellow" (Ridg.), with "lemon-yellow" tips. Base of stem white, 10–12 cm. thick.

CLAVARIA BOTRYTIS Fr. Infrequent. Tolland.

Under spruce and pines. The spores in some specimens measure shorter, and indicate slow maturity. The striations on the spore wall are faint and must be looked for under magnifications of about 1500 diam. Spores of the Colorado form measure 10–13 (15) x 4–5 μ. The spores of some of my Michigan specimens measure 10–15 (16) x 5–6 μ, all striate. I am

inclined, however, to think the Colorado plant is merely a form; at least it is not *Clavaria botrytoides* Pk. (*N. Y. State Mus. Bull.*, 94: 49. 1905.)

CLAVARIA CORNICULATA Fr. (*C. muscoides L.*) Frequent. Tolland. Under conifers.

CLAVARIA CRISTATA Fr. Frequent, Tolland. Under pines.

CLAVARIA FLAVA Fr. Occasionally abundant, Leal and Tolland. Under pines. Spores 10–14 x 3.5–4.5 μ, slightly yellowish, or subhyaline in microscope, the spore wall practically smooth under very high magnification.

CLAVARIA FUMOSA Fr. Rare. Leal, Tolland.

On moss and humus under spruce and fir. The color is smoky-brown with tint of purple. It forms dense clusters of usually simple clubs 5–8 cm. high, 2–5 mm. thick; the hymenium is provided with cylindrical hyaline cystidia; spores oblong, 9–10 x 5 μ hyaline.

CLAVARIA LIGULA Fr. Uncommon. Tolland. Under pines.

CLAVARIA PISTILLARIS Fr. forma TRUNCATA. (See Atkinson, *Mushrooms*, p. 203. 1900, and E. T. Harper, *Mycologia*, V. 263. 1913.) Typical plants occur also. Infrequent. Tolland, Leal. Under pines.

CLAVARIA PYXIDATA Fr. Infrequent. Leal. On poplar log.

AGARICACEAE

AMANITA MUSCARIA Fr. Infrequent. Tolland.

In groves of pine and poplar. American authors nearly always include "red" in giving the colors of the pileus, but no one, to my knowledge, has clearly stated that the brilliant-red European color form had been observed in this country.

I saw this form in Sweden, but until I came across the collection at Tolland, assumed that it did not occur in the United States. These specimens had a uniform "scarlet" to "scarlet-red" (Ridg.) pileus, just like those of Europe; the volva was "light-buff" to "naples-yellow" (Ridg.) and the thick outer edge of the annulus was also decorated by "naples-yellow" floccose tufts which had been torn from the volva. The spores measure 9–12 x 6–8 (9) μ, with a very large oil globule.

If we consider the well-known orange-yellow to yellow form as the center of the color shading, we get as one extreme this brilliant red form in the Rocky Mountains, and as we go east and south to Virginia, I have noted that the colors tend to be much paler, even when in a favorable growing condition. The tendency to fade rapidly to dingy white after maturity is much more common there than in the North.

ARMILLARIA MACROSPORA Pk. Rare. Tolland.

Mossy or moist ground under spruce and fir; solitary, rarely two or more. Because of the inadequate description published by Peck, it seems desirable to give an emended account of this species, especially because another large-spored plant, *A. evanescens* (Lovejoy) Murrill, has been described from the Rocky Mountains:

Pileus fleshy, 8–12 (20) cm. broad, convex, obtuse, then expanded-plane, becoming turbinate in age, with a gelatinous pellicle which is viscid when moist, even, glabrous, shining when dry, "cinnamon-buff" to "pinkish-buff" (Ridg.); sometimes tinged brownish-yellowish; margin acute, sometimes subappendiculate from the veil; flesh very thick in centre, abruptly quite thin at margin, white; gills acuminate-long-decurrent, narrow, crowded, a few forked toward margin of pileus, white to "light buff" (R.), edge entire; stem 4–7 (9) cm. long, 1.5–3 cm. thick, subequal or tapering downwards, stout, solid, white within; veil thick, persistent, rather membranous, at first sheathing the stem to middle or above, terminating in a flaring, membranous portion which becomes the annulus, at length torn and forming subconcentric patches colored like pileus, the thin outer layer of the veil composed of gelatinous hyphae and viscid when wet; odor subfarinaceous when flesh is crushed, taste like rancid meal or somewhat disagreeable; spores 13–16 (17) x 5–6 (rarely 7) μ, subcylindric-subfusiform, hyaline, granular within; cystidia none; basidia 85–90 x 9–11 μ.

ARMILLARIA MELLEA Fr. Rare in the conifer forests, but then attached to coniferous wood.

ARMILLARIA VISCIDIPES Pk. Solitary. Not infrequent. Tolland, Leal.

Solitary on the slopes of the mountain ridges under pine and spruce. The stem, whose enclosing veil is viscid when young and fresh, is subequal or usually tapering downwards; the spores are minute, 5–6 (7) x 3–4 (5) μ, so that Peck (*Ann. Rep. N. Y. State Mus.*, 44: 128) seems to have noted only the extreme larger size; furthermore, a mount of the gills usually shows a large number of immature, subspheroid spores. The odor is subalkaline, penetrating and distinguishing.

CANTHERELLUS CIBARIUS Fr. Frequent in August, not seen later.

CANTHERELLUS LUTESCENS Fr. (Epicrisis). Infrequent. Tolland, Leal.

On rotten coniferous wood. The stature is that of *C. infundibuliformis*. Pileus "fawn color" (Ridg.); gills "ochraceous-salmon," stem "pinkish-cinnamon"; the spores measure 10–12 (13, 15) x 4–5.5 μ, subcylindrical, hyaline.

CLAUDOPUS NIDULANS Fr. Rare. Tolland. On conifer log.

CLITOCYBE CANDICANS Fr. Infrequent, Tolland, Leal. In fir and spruce forests.

CLITOCYBE CANDIDA Bres. Rare. Under fir and spruce in high mountains.

CLITOCYBE CONNATA Schum.-Bres. (*Fung. Trid.*, I. Pl. XXXIII.) Infrequent, Tolland.

On rotten coniferous wood and debris. *Clitocybe overholtsii*, Murrill (*North American Flora*, 9. Part 6, p. 403), is doubtless the same thing. It varies in its habit, and the connate character is not always dependable.

CLITOCYBE FRITILLIFORMIS Fr. Rare. Tolland. On moss under fir.

CLITOCYBE GEOTROPA Fr. Rare. Leal. On conifer log.

CLITOCYBE LACCATA Fr. Frequent. Tolland, Leal. On low ground.

CLITOCYBE MAXIMA Fr. Infrequent. Tolland. Under spruce and pine.

CLITOCYBE PICEINA Pk. Infrequent. Leal. Under conifers.

CLITOCYBE PITHYOPHILA Fr. Infrequent. Tolland. Under fir.

Clitocybe sordarius (Fr.) (*Paxillus sordarius* Fr.). Rare. Tolland. On banks, attached to very rotten wood. Spores narrow, subfusiform, hyaline, 8–9 x 3.5–4 μ.

Clitocybe tornata Fr. Infrequent, Tolland. On decayed wood.

Collybia acervata Fr. Infrequent, Leal, Tolland.

On much-decayed wood of conifers, forming dense subconfluent, caespitose clusters of many individuals. The conception of this species as described in *Agaricaceae of Michigan*, I. 759, is entirely erroneous, by the fact of its very incompleteness. The species would not be recognizable by that description, or indeed by that of many other books. Even Fries did not put sufficient emphasis on the densely caespitose character of the stems, with which many of the other characters are correlated.

Collybia albiflavida (Pk.) Kauff. var. **montana** var. nov. Rare. Tolland. Among grass in meadow, edge of coniferous forest.

This departs from the species in its somewhat broader gills, 6–10 mm. broad, which become "pale ochraceous-orange" (Ridg.), and the spores measure 8–9 (10) x 5–6 (6.5) μ. In stature, habit and the presence of cystidia, and the other characters, it corresponds to the well-known eastern species.

Collybia butyracea Fr. Not seen after August, Tolland.

Collybia cirrata Fr. Infrequent. Leal. On debris of conifer needles.

Collybia colorea Pk. Rare. Leal. On conifer log.

Collybia confluens Fr. Frequent, Leal. On ground in woods.

Collybia dryophila Fr. Frequent. Leal. Under spruce and fir.

Collybia tuberosa Fr. Frequent, Tolland. On decaying fungi.

Collybia tenuipes (Schw.) Sacc. Infrequent. Tolland. Attached to wood.

Collybia velutipes Fr. Infrequent, Tolland. On wood of Salix, etc.

Coprinus atramentarius Fr. Infrequent, Tolland. On the ground.

Cortinarius alboviolaceus Fr. (Inoloma). Frequent. Leal. In alluvial soil along streams.

Cortinarius alutaceofulvus Britz. (Telamonia). Infrequent. Leal, Tolland. On moist, mossy ground, or on mosses under spruce.

This is to be considered as a segregate of *C. bivelus* Fr. It differs from its nearest relatives like *C. bivelus*, *C. rusticus* Karst., and *C. laniger* Fr. because of its almost spherical spores, which measure 6–7.5 x 5–6 μ. Furthermore, *C. bivelus* and *C. laniger* have a distinct odor according to Fries. This quartet of species has presented considerable difficulty, but an accumulation of data makes it possible to distinguish three of them as occurring in this country. *C. alutaceofulvus* occurs also in the Adirondack Mountains under spruce. In Overholts's list I referred a collection of what is probably this species, to *C. rusticus*.

Cortinarius anomalus Fr. (Dermocybe). Frequent, Leal. In moist debris and leaves, under pine and spruce.

Cortinarius angulosus Fr. (Hydrocybe). Infrequent. Leal. Under conifers. This is a firm plant, which, like its nearest relatives *C. isabellinus* and *C. renidens*, becomes ochraceous on losing moisture; from both of these it differs in its spore characters and habit.

Cortinarius arquatus Fr. (Bulbopodium). Rare. Leal. Under spruce and fir.

This is apparently distinguished from the larger *C. atkinsonianus* by the weak violaceous colors, the broad gills, and the peculiar violaceous base of the stem, which, as Fries remarks, is not itself bulbous or marginate, but is surrounded and enlarged by the volva-like remnant of the veil. Our Colorado specimens were not strikingly volvate, but agree well with Ricken's account and his spore-size, 12–15 x 7–8 μ. Other European notices agree in giving the spore-size 10–12 μ long. But no one except Ricken has given us a critical study of it since the time of Fries. It is of course possible that two species occur in Europe.

Cortinarius atkinsonianus Kauff. (Bulbopodium). Infrequent. Leal. Under conifers.

Cortinarius balteatus Fr. (Phlegmacium) form *pallidus*. Rare. Leal.

These specimens lacked the violaceous-purplish tinge on the margin of the pileus; but Fries noted forms of this kind in Sweden. The broad, obtuse pileus is out of proportion to the short stem. The gills are very broad and distinguish this species from its relatives. Ricken says the stem is peronate, but on what authority, I am unable to determine; at all events, he does not depend on Fries.

Cortinarius bistreoides sp. nov. (Telamonia).

Pileus 2–4 cm. broad, submembranaceous, fragile, at first conic-campanulate, then expanded-plane or repand on margin, usually with a subacute umbo, *glabrous*, silky-shining when dry, even, "mummy brown" (Ridg.) when moist, "ochraceous-buff" on drying, *umbo at length "bistre,"* and finally bistre elsewhere, with a very thin margin, which is at first delicately white-silky, at length incised or crenate-plicate; flesh concolor, hygrophanous, quite thin. Gills adnate, often sinuate, strongly ventricose, *broad*, definitely subdistant, at first pallid-brownish, then "tawny," edge white-flocculose. Stem *slender*, 4–6 cm. long, 2–4 mm. thick, equal, somewhat rigid-elastic, straight or flexuous, solid, innately silky-fibrillose and shining when dry, slowly fuscescent, incarnate-tinged within, scarcely marked by zones of the evanescent, whitish universal veil. Odor slight, radishy-earthy, taste slight or none. Spores elliptical, 10–12 x 5–6 (7) μ, tuberculate at maturity, dark rusty brown in microscope.

Gregarious or subcaespitose, in moist places under spruce and fir. Leal, Colorado. August.

Distinguished from its allies by its large spores, and the prevailing bistre shades of the pileus. The flesh of the stem is solid and tinged by a shade of incarnate-brown, then slowly fuscescent. The cap becomes blackish-streaked or stained in age. The scanty cortina is white. *C. badius* Pk., which has large spores, is entirely different in the smaller size of the plant and in its colors, etc. It must not be confused with *C.*

nigro-cuspidatus or *C. paleaceus,* whose spores are much smaller.

Cortinarius bivelus Fr. (Telamonia). Infrequent. Leal. Tolland. Under spruce and pine. See remarks under *C. alutaceofulvus.*

Cortinarius brunneofulvus Fr. (Telamonia). Infrequent. Leal. In mixed woods.

Cortinarius caesiocyaneus Britz. (Bulbopodium). Infrequent. Leal. Alluvial soil, forest.

Cortinarius callisteus Fr. (Inoloma). Rare. Leal. Alluvial soil, under spruce, fir and alder.

This is the second time I have collected this fine species. Fifteen years ago, I obtained a few plants in hemlock and pine woods at Ithaca, N.Y. It is quite distinct and entirely like the European plant.

Cortinarius cinnamomeus Fr. (Dermocybe). Common. Leal. Tolland. On moss and debris under pine, spruce or fir.

Cortinarius citrinellus sp. nov. (Bulbopodium).

Pileus up to 10 cm. broad, fleshy, convex-expanded, very viscid, then somewhat floccose-dotted from the drying gluten, at first "olive-lake" to "buff-citrine" (Ridg.), finally "clay-color" to "honey-yellow," the margin at first incurved and tomentose; flesh thick, except on margin, at first tinged "primrose-yellow" (Ridg.), then whitish. Gills adnate and rounded behind, then sinuate, moderately broad, 8–10 mm., ventricose, close, becoming slightly subdistant, at first "primrose-yellow" (Ridg.), finally "tawny." Stem 5–7 (8) cm. long, apex 1.5–2 cm. thick, at first marginate-bulbous, becoming oval-bulbous, abruptly short-obtusely-pointed below bulb, which is densely fibrillose-tomentose from the "primrose-yellow" veil, elsewhere veil is evanescent and surface of stem concolorous with that of the pileus. Cortina yellowish, odor and taste slight. Spores broadly ellipsoid to globose, 8–9 x 6–8 μ, rough, brownish under microscope.

Solitary or scattered. Leal, Colorado. Under pine and spruce. August.

This differs from its allies in the subglobose spores. It ap-

proaches *C. prasinus* in its colors, but with less green. It differs from *C. virentophyllus* in spores, colors and habitat. When quite young, the green shades are more manifest. In wet weather, the bulb is viscid from the veil-remnants. The cortina is at first attached to the margin of the bulb, thus indicating its position in the subgenus Bulbopodium.

CORTINARIUS COLYMBADINUS Fr. (Dermocybe). Very common in a restricted area of spruce and fir forest. Leal.

This is form (B) of Fries's *Monographia*, which he collected under pines. When it is moist and drying, the subhygrophanous character is apt to lead one into the hygrophanous groups. The "tawny-olive" to "old-gold" (Ridg.) color of the moist cap, the tendency of the margin to become geniculate, the rather broad, almost subdistant gills and spores which measure 7–8 (9) x 6–6.5 μ, separate it from its allies. This form had only a slight radish odor, while form (A) of *Monographia,* which occurred under beech, is said to have had a very strong odor of radish.

CORTINARIUS CROCEOCONUS Fr. Rare. Leal. Mossy ground under conifers.

CORTINARIUS CYANOPUS Fr. Rare, Leal. Under spruce and fir.

This seems to agree well enough with the conception handed down to us. The spores measure 10–12 x 8–9 μ. It is Ricken's plant, except that both he and Fries limit it to frondose woods. Since its violet-stemmed allies are already numerous, I refrain from segregating it on such slight grounds. *C. aggregatus* Kauff. has much smaller spores. Further study of these violet species may bring out additional useful characters. The gills of the Colorado plant were "deep vinaceous-lavender" (Ridg.) at first, and their edge noticeably crenulate. The upper part of the stem within and without had the color of the young gills. The pileus was "cinnamon-buff" to "clay color" (Ridg.).

CORTINARIUS CYLINDRIPES Kauff. (Myxacium). Infrequent. Tolland. In moist places under conifers.

CORTINARIUS DECUMBENS Fr. (Dermocybe). Rare. Leal. Under spruce and fir.

The whole plant is at first "ivory white" (Ridg.), later the gills become "Sayal-brown" from the spores. The specimens

were larger than the typical size found by Fries, but he notes that such extremes do occur. The rather stout and decumbent stems soon become spongy-hollow and split easily in the longitudinal direction. Spores measure 7–8.5 x 5–6 μ. This is my first collection.

CORTINARIUS DELIBUTUS Fr. (Myxacium). Infrequent, Leal. On mosses under conifers.

This differs from *C. sphoerosporus* Pk., which is similar and occurs in Eastern United States, by its somewhat larger spores, the white flesh of the pileus and in the gills which are not truly violaceous in the young stage. Its gills are more crowded than in the typical form, a form which is also reported by Fries. The color of the pileus varies from "mustard-yellow" (Ridg.) to "cream-buff."

CORTINARIUS DIBAPHUS Fr. Rare. Tolland. Under spruce.

CORTINARIUS DILUTUS Fr. (Hydrocybe). Infrequent, Leal. Tolland. On mosses under conifers.

By reason of its strongly hygrophanous character, the pileus, which is almost "chestnut-brown" when young and moist, fades to a pale "cinnamon-buff" (R) as it develops and loses moisture. The spores are spheroid, 6–7 x 6 μ. Its nearest relative is probably *C. rubricosus* Fr.

CORTINARIUS ELEGANTIOR Fr. Rare. Leal. Under alpine fir.

This fine species was described by Fries from the mountains, under fir. Our plants agree exactly with his account. Ricken says the gills are broad, but such is not the Friesian description. The spores measure 12–15 (16) x 8–9 μ. The variety from frondose woods described in *Agaricaceae of Michigan, I.* 355, probably belongs elsewhere. The Colorado plants have slightly larger spores than any recorded by European authors, but misinterpretation of Fresian plants in the middle and south of Europe, is to be expected. We have already in this country three or four superficially similar, but really quite distinct species.

CORTINARIUS EVERNIUS Fr. (Telamonia). Infrequent, Leal. On mosses under conifers.

Quite typical; but variations in size, and changes due to the

fading of the intense violet color of the stems, are frequently very confusing.

Cortinarius gentilis Fr. (Telamonia). Frequent, Leal, Tolland. In deep mosses, under conifers, etc.

Sharply marked by its broad and distant gills, which often become very distant as the plant matures and the drying cap pulls up on the margin. Except for its longer stems and habitat, it has somewhat the appearance of *C. distans* Pk. But in the latter the stem is cingulate by the faded whitish remnants of a brownish veil, while in *C. gentilis* the zone in the middle is "yellow-ochre" and due to a yellow veil. The spores of *C. gentilis* are also slightly larger than in *C. distans*, and measure 8–9 (10) x 5.5–6 (7) μ.

Cortinarius glandicolor Fr. (Telamonia). Rather frequent. Leal. Tolland. In debris under conifers, especially fir.

This is most easily confused with *C. punctatus* Fr. and stout forms of *C. uraceus* Fr. It has about the stature and shape of *C. distans* Pk., but that species never has a fuscescent tendency, while in *C. glandicolor* the whole plant when it reaches maturity becomes fuscous and in age even blackish. I have found the latter in this country only in the mountain forests, in the Adirondacks, the Rockies, and the Olympics. Its spores are very slightly longer than in *C. distans*, but smaller than in *C. punctata*. Its gills vary from close to subdistant, in some forms distant in age. The stem is at first whitish, but in age only the annular zones of the veil remain whitish. In *Agaricaceae of Michigan*, p. 422, it is compared with its relatives, but at that time I had not become definitely acquainted with it. The pileus is campanulate, its umbo quite variable from small and pointed to broadly mammillate and obtuse, and small plants often have the shape of *C. rigidus*, but differently colored.

Cortinarius glaucopoides sp. nov. (Bulbopodium).

Pileus 5–10 cm. broad, fleshy, convex, obtuse, then expanded-plane, often irregular from crowding, with a viscid, separable pellicle, glabrous, even, "antimony-yellow" (Ridg.) to "pale orange-yellow," unicolorous, *deeper lutescent with age*, not streaked, the thin margin at first incurved; flesh thick, abruptly

thinner on margin, *white or whitish at first, distinctly lutescent.* Gills adnate-emarginate with tooth, somewhat narrow to medium broad, up to 5–8 (9) mm., close to crowded, at first "pale vinaceous-drab" (Ridg.) becoming "ochraceous-tawny," edge suberose. Stem 4–7 cm. long, 10–15 mm. thick, straight or curved, subequal above the *small, abrupt, oblique, marginate bulb,* solid, at first slightly superficially fibrillose, cortina white, at length glabrescent and innately silky, white or whitish, sometimes tinged "drab" at apex, *lutescent toward base within and without,* bulb flattened below. Odor slight but penetrating, taste mild. Spores narrowly elliptical, almost smooth under high powers, 8–9 x 4–5 μ, pale rusty brown in microscope. Caespitose or in gregarious clusters. Leal, Colorado. August. Under conifers in mountain forests.

This has the habit and spores of *C. glaucopus*, but the colors are sharply different, and the pileus is never streaked. The remark of Fries (*Monographia*, I. p. 18), that "it (*C. glaucopus*) is changeable as it is variable," has doubtless led later mycologists to take the easy road of putting a number of species under this name, especially when the lutescent character of flesh and stem was well marked and other characteristics seemed to fit. I should not like to attempt the solution of the question as to which of the segregates is to be considered the type. The species before us could be so considered, except that Fries does not report *C. glaucopus* in mountainous coniferous forests.

Cortinarius griseoluridus sp. nov. (Myxacium).

Pileus 5–8 (10) cm. broad, fleshy, broadly convex then expanded, obtuse, rarely subumbonate, with a distinct glutinous pellicle, at first "light quaker drab" (Ridg.), especially on margin, elsewhere becoming "*olive-ochre*" *on a* "*smoky-gray*" *ground color,* even, glabrous at first, at length scaly-spotted or variegate-virgate from the drying gluten, margin at first incurved, sometimes more purplish-tinted; flesh very thick on disk, abruptly thin on margin, soft, moist, at first tinted violaceous-gray, then watery-whitish, with a tint of "ochre-olive" (Ridg.) under pellicle. Gills adnate-subdecurrent, then emarginate with tooth, *close to crowded,* medium broad, at first "pale vinaceous-drab,"

soon "avellaneous," finally rusty-brown, *edge minutely crenulate.* Stem 4–9 cm. long, 10–20 mm. thick at apex, stout, often tapering upward from a clavate base, sometimes subequal and longer, sometimes with a large oval bulb and shorter, bulb up to 30 mm. thick and often abruptly short-pointed below, firmly stuffed to hollow, terete or compressed, at first tinged violaceous within and without, apex at first flocculose-furfuraceous and soon white, elsewhere *covered by the thin, viscid, appressed, subconcentric, grayish-lutescent patches* from the glutinous universal veil. Odor and taste mild. Spores broadly oval to subglobose, subacute at one end, thick walled, under oil-immersion with interrupted ridges on surface so as to appear subreticulate, pale rusty in microscope, 8–10 x 7–8.5 μ.

Gregarious. Leal, Colorado. Under conifers in mountain forests. August.

This differs from *C. salor* Fr., to which it is related, by its dull or sordid hues, by its close gills, stuffed to hollow stem and its habitat under conifers. It is also apparently related to *C. emunctus* Fr., but no reliable microscopic data are at hand for that species. Britzelmayr's species *C. griseolilacinus* and *C. subflexuosus* are not sufficiently described. This species was very abundant over a small flat at the base of the slopes, under spruce and fir. When very young, the stem is violet within and without, but quickly changes. A few hours after it is picked, the pileus changes entirely to "buffy-olive" (Ridg.), and in large specimens its surface is covered with numerous spot-like floccose scales.

Cortinarius illuminus Fr. (Hydrocybe). Infrequent, Leal. Gregarious under spruce and fir.

Fries notes that this is difficult to distinguish because its characteristics are not prominent. He reports it from both frondose and conifer woods. The plants I have referred here possess gills with an unusual shade of color, soon "cinnamon-rufous" to "terra cotta" (Ridg.). Its stems are rather long-attenuate upwards and subventricose downwards, with a short abruptly attenuate base which is often decumbent, soon hollow. It is related to *C. armeniacus* Fr., but the stems become sordid to

dingy rusty brown in age. Its habit is that of a stout-stemmed *C. rigens.* The colors of the pileus when moist are "chestnut-brown" to "cinnamon-rufous," and fade slowly; its texture is rigid and brittle. The spores are small, 7–8 x 5 μ.

Cortinarius injucundus (Weinm.) Fr. (Telamonia). Rare, Leal. Under conifers.

This belongs to the *C. brunneus* group and is about the same stature and colors, but differs from *C. brunneus* in that the apex of the stem, both within and without, as well as the young gills, are violaceous; the gills are similar, but are attached with a decurrent tooth; and the pileus is markedly variegated-streaked in two shades of brown; the spores are about the same. Barbier (*Bull. Soc. Myc.*, 27: 183) considers it merely a form of *C. brunneus.* Cooke's illustration, Plate 823, shows spores which manifestly do not fit our plant. The spores of the Colorado plants are broadly elliptical, 8–9 (10) x 6–7 μ.

Cortinarius isabellinus Fr. (Hydrocybe). Frequent, Leal, Tolland. In hard soil under pines.

Characterized by its rigid-brittle stem and cap, with broadly umbonate and usually gibbous pileus, which is umber when moist, "olive-ochre" (Ridg.) when dry, and with thick and rigid, rather broad gills. Pileus 3–5 cm. broad; stem 4–6 cm. x 6–7 mm. thick and nearly equal. All parts on losing moisture begin to show the "olive-ochre" color, including the cortina. The spores measure 8–9 (10) x 4.5–5 μ.

Cortinarius laniger Fr. Not infrequent. Tolland. Under conifers.

Its near relative, *C. bivelus* has a glabrous pileus, while in this, the surface is at first and for a while hoary-canescent, or with appressed superficial silky-white fibrils, becoming glabrous in time. Its spores are rather variable, 8–11 x 5–6 μ. The enlarged base of the clavate stem is quite tomentose-mycelioid and sometimes quite villose upwards.

Cortinarius lilacinipes Britz. (Bulbopodium). Infrequent, Leal. Under spruce and fir.

The narrow, crowded gills, at first "vinaceous-fawn" (Ridg.) in color, the lutescent bulb attached to an ochraceous mycelium,

and the pale yellow, "antimony-yellow" (Ridg.) color of the pileus, are the main features of this good-sized plant. I refer it here with some hesitancy, as the Britzelmayr species are hard to recognize. The spores when examined under the oil-immersion are reticulate-rough and measure 11–13 (14) x 6–7 (8) μ. The gill-color of the young plant persists to maturity, so that they appear incarnate-tinged even in age. The apex of the young stem is at first tinged with lilac or vinaceous.

CORTINARIUS MALICORIUS Fr. (Dermocybe). Infrequent. Leal, Tolland. Under conifers.

Cortinarius metarius sp. nov. (Bulbopodium).

Pileus 4–7 (8) cm. broad; fleshy, convex-expanded, then plane, with a viscid pellicle which is at the very first pale bluish-violaceous, *quickly lutescent*, then "mustard-yellow," "naples-yellow" or "apricot-yellow" (Ridg.), glabrous, even, the thin margin at first incurved and minutely tomentose; flesh medium thick on disk, tinged at first with violaceous-incarnate tints, soon whitish then *lutescent*. Gills adnexed, rounded behind, then sinuate-uncinate, *narrow*, 4–6 (7) mm. broad, crowded, at first incarnate or amethystine, "heliotrope gray" (Ridg.), soon pale "clay-color." Stem 4–6 cm. long, 10–18 mm. thick, subequal above the *shallow and broad, marginate-depressed bulb*, sometimes compressed-subturbinate, solid, at first more or less violet within and without, soon white then lutescent, bulb covered by remnants of a yellow universal veil, superficially fibrillose above bulb. Odor and taste mild or slight. Spores narrowly ellipsoid, inequilateral, almost smooth, pale yellowish-rusty under microscope, 9–12 (13) x 5–6 μ.

Solitary, on the ground in mountain forests of spruce and fir. Leal, Grand Co., Colorado. August.

This is exactly halfway between *C. calochrous* and *C. caerulescens*, and these three species offer good material for the "lumpers" in taxonomy. It differs from *C. calochrous*, in the distinctly larger spores, and the color changes in the plant; from *C. caerulescens*, in its smaller spores, the presence of a yellow universal veil, and the narrow gills. The name refers to the limitations imposed by this separation.

Cortinarius mucifluus Fr. (Myxacium). Infrequent, Tolland. Moist places under bushes.

Cortinarius multiformis Fr. Frequent, Leal. In troops, under conifers.

Cortinarius nigrocuspidatus sp. nov. (Telamonia).

Pileus 2–3.5 (4.5) cm. broad, submembranous or slightly fleshy, at first conic-campanulate, then campanulate-expanded with an obtusely *conical, black, prominent umbo,* sometimes mammillate, innately silky-fibrillose, silky-shining when dry, *glabrous,* even, hygrophanous, "sepia" or "army brown" (Ridg.) fading to "wood-brown" or paler, except umbo, the margin at first decorated by narrow shreds of the white universal veil; flesh thin, concolor, hygrophanous, fading. Gills adnate, then emarginate with decurrent tooth, *subdistant, rather broad,* ventricose, somewhat wrinkled on sides, at first pallid-brownish, then "cinnamon" to "tawny-cinnamon." Stem slender, 4–6 cm. long, 3–5 mm. thick, elastic, equal, flexuous, stuffed, then hollow, "sepia" within and without, scarcely fuscescent, unequally zoned downwards by the silky white remnants of the delicate universal veil, sometimes with only a median zone. Odor and taste slightly of radish. Spores short ellipsoid to suboval, 8–9 (10) x 5–6 μ, obtuse, minutely and indistinctly rough, rusty-brownish under microscope.

Subcaespitose or gregarious. Leal, Colorado. Under spruce and fir in mountain forests.

Related to *C. stemmatus* Fr., from which it differs in its subdistant, broad gills, and somewhat larger spores. It has to some extent the appearance of *C. paleaceus,* but the pileus is glabrous, and the spores larger. Sepia is the prevailing color in fresh specimens; it is deeper and darker on the umbo of the pileus.

Cortinarius obtusus Fr. Frequent, Leal, Tolland. Caespitose or gregarious, under fir and spruce.

Cortinarius oricalchius Fr. (Bulbopodium). Infrequent, Leal, Tolland. Under spruce and fir.

This species seems to be sufficiently well known in Europe. My Colorado collections were excellent examples of the species.

In the mountains of northwestern United States, the darker form, which is probably *C. atrovirens* Kalchb., occurs. It is surprising that these are not known in the eastern part of the country.

CORTINARIUS PERCOMIS Fr. (Phlegmacium). Infrequent, Leal. Under spruce and fir.

The distinct, penetrating, sweet-aromatic odor is one of its characteristics. It is related to *C. cliduchus* Fr., and Ricken has apparently confused the two species as they were conceived by Fries. Unfortunately, Fries did not mention the odor for either species, but he limits *C. percomis* to pine and fir forests, and *C. cliduchus* to beech and oak. He also makes it clear that in *C. percomis*, the color of the flesh and gills is pale yellow, citrin- or sulphur-yellow, and that the other parts of the plant are flavescent; in *C. cliduchus* the colors are darker, "luteus" to "fulvous." My collections, placed under *C. percomis*, all tended to the paler group of colors. The spores measure 10-12 (13) x 5-6.5 (7) μ.

Cortinarius pinetorum (Fr.) comb. nov. (Inoloma).

Cortinarius argentatus var. *pinetorum* Fr., *Monogr. Hymen. Suec.*, I. 46. 1851. Leal. Under conifers.

This appears to be the Fresian form of *C. argentatus* occurring under conifers. It is quite close to the form described in *Agaricaceae of Michigan*, I. 381, under *C. argentatus*. There is a peculiar lack of constancy in the width of the gills; sometimes they are distinctly narrow, sometimes medium broad; likewise the spacing varies, the narrow gills are crowded, the others tend to be subdistant. Forms under pines in Michigan showed the same variation. The typical *C. argentatus* is larger and occurs in oak woods.

CORTINARIUS PUNCTATUS Fr. (Telamonia). Rare, Leal. Under conifers.

This I consider form (B) of the *Monographia* of Fries. The series of species and forms to which *C. punctatus*, *C. glandicolor* and *C. uraceus* (stout form) belong, is a difficult Cortinarius problem, fully recognized by Fries, who, however, did not hand down to us the spore records. Had he been able to do this, a good deal of the puzzle might be open to solution. *C. punctatus*

as here recognized, has spores 10–12 (13) x 6–8 (9) μ, with occasional spores up to 16 μ long. No sign of a veil could be observed. The pileus is "vandyke brown" when fresh and moist, but both it and the stem are markedly fuscescent, so that the plants become quite dark or blackish in age. The gills are distant, broadly adnate and rather broad.

Cortinarius purpurascens Fr. (Bulbopodium). Infrequent, but typical. Leal. Under conifers.

Cortinarius rigens Fr. (Hydrocybe). Infrequent, Tolland. Under fir.

This has the habit of *C. scandens*, but becomes much larger. The spores measure 7–9 x 4–5 μ.

Cortinarius rigidus Fr. (Telamonia). Frequent, Leal, Tolland. On mosses under conifers.

Its markedly broad gills, and the concentric white zones on the fuscous-brown stem, distinguish it from its relatives. The pileus is conic-campanulate, but umbo is subobtuse.

Cortinarius scandens Fr. (Hydrocybe). Frequent, Leal, Tolland. Under conifers.

Cortinarius splendidus Pk. (Myxacium). Rare, Leal. In moss, under pine and spruce.

Cortinarius suillus Fr. (Telamonia). Infrequent, Leal. Under conifers.

This fine large plant was met for the first time; the "ochraceous-salmon" to "apricot-buff" colors of its pileus make it fairly easily recognizable. The stem is stout, clavate-bulbous and white, pileus and gills turn slowly blackish when bruised. The spores measure 9–10 (11) x 5–6 (7) μ. The veil is rather evanescent.

Cortinarius uraceus Fr. (Hydrocybe). Rare, Leal. Under conifers.

Cortinarius vibratilis Fr. (Myxacium). Infrequent, Leal, Tolland. Mixed and conifer woods.

Cortinarius violaceus Fr. Infrequent, Leal. On moss under fir.

Crepidotus versutus Pk. Uncommon, Tolland. On decayed wood.

ENTOLOMA SERICEUM Fr. Rare, Tolland. Mixed woods.

FLAMMULA ALNICOLA Fr. (sense Ricken). Rare, Tolland. On end of fir log.

FLAMMULA HIGHLANDENSIS Pk. Infrequent, Leal. On decayed coniferous wood.

FLAMMULA INOPODA Fr. Rare, Tolland. On end of a fir log.

FLAMMULA LUBRICA Fr. Rare, Tolland. On very rotten coniferous wood, under fir.

FLAMMULA LUPINA Fr. Rare, Leal. On decaying coniferous log.

FLAMMULA MIXTA Fr. (sense of Ricken). Rare, Leal.

FLAMMULA PENETRANS Fr. Frequent, Leal, Tolland. On coniferous logs and stumps.

FLAMMULA SPUMOSA Fr. Infrequent, Tolland.

One lot was studied during its development on rotten pine timber lying in a dark shed next to our cabin. On the day when these were picked, another lot was brought in from outdoors, also on a very rotten pine log. Careful comparison showed that the gills of the former had remained paler than in the typical plant showing scarcely any yellow at maturity. The gill-colors of the two lots of dried herbarium specimens do not match, and a word of caution is necessary when comparing dried specimens for shades of color. Both were microscopically alike when mature.

GALERA HYPNORUM Fr. Infrequent. Leal. On moss, under conifers.

GOMPHIDIUS ROSEUS Fr. Infrequent, solitary. Leal, Tolland. On moss, etc., under conifers.

Differs from *G. viscidus*, in the smaller size, upper part of stem white, "vinaceous-pink" to "pinkish-buff" pileus, and smaller spores. Both have a viscid, but not truly glutinous cap and veil. The spores measure 15–18 (20) x 5–6 μ, although in both collections an occasional larger one may be found. Base of stem is "empire yellow."

GOMPHIDIUS VISCIDUS Fr. Infrequent, solitary. Leal, Tolland. Under pines, spruce or fir.

Although not common, nor as luxuriantly developed as in

the conifer forests of Europe, this is doubtless the same as the European species. Stem becoming "apricot-orange" (Ridg.) within and without; spores 18–24 x 6–7 μ.

Hygrophorus agathosmus Fr. Rare, Leal. Under pines.

Hygrophorus calophyllus Bres. Rare. Under pine and spruce.

This is my first collection of this beautiful gilled plant. It is a good species. The "sea-shell pink" (Ridg.) color of the gills is lost in the dried specimens.

Hygrophorus chrysodon Fr. Tolland. Infrequent, but copious where it occurs; in gregarious or caespitose clusters. Under conifers, low ground.

Hygrophorus conicus Fr. Rare, Tolland. In low ground.

Hygrophorus discoideus Fr. Rare, Tolland. Under spruce.

Hygrophorus eberneus Fr. (form *flavescens*). Infrequent, Leal. Under pines.

Hygrophorus fuscoalbum Fr. Common during September, Tolland. Under conifers.

Hygrophorus hypothejus Fr. Common, Tolland. Under pines.

Most often the gills do not become as deep yellow as in the typical form.

Hygrophorus pudorinus Fr. Common during September, on the slopes of the mountains under pine, spruce or fir. Tolland.

Hygrophorus virgineus Fr. Rare, Tolland, Leal. On beds of spruce needles; in open meadow.

Inocybe albodisca Pk. (form). Infrequent. Leal. In open meadow.

Inocybe caesariata Fr. Infrequent. Tolland. Under pines.

Inocybe eutheloides Pk. Frequent. Leal. Under mixed poplars and conifers.

Inocybe flocculosa Berk. Infrequent. Leal. Low ground.

Inocybe geophylla Fr. Frequent. Tolland. Leal. Under conifers and in open meadow.

INOCYBE LANUGINOSA Fr. Infrequent. Tolland. Leal. On mossy bank among debris.

INOCYBE SUBDECURRENS E. & E. Infrequent. Leal. Under mixed poplars and conifers.

LACTARIUS CAMPHORATUS Fr. Common, Tolland, Leal. Moist forest flats along streams.

LACTARIUS DELICIOSUS Fr. Common, Tolland, Leal. Under conifers.

In this region the plants frequently have the gills colored "Hellebore green" (R) as they become old.

LACTARIUS INSULSUS Fr. Infrequent, Tolland, Leal. Under spruce on banks.

LACTARIUS MACULATUS Pk. Infrequent. Moist places under spruce.

LACTARIUS SCROBICULATUS Fr. Infrequent. Tolland, Leal. Under spruce and fir and pine.

LACTARIUS SUBDULCIS Fr. Frequent, Tolland. Under pine, etc., moist places.

LACTARIUS THEIOGALUS Fr. Frequent, Tolland. Under pine and poplar.

LACTARIUS TORMINOSUS Fr. Infrequent. Under spruce on moist ground.

LACTARIUS TRIVIALIS Fr. Frequent. Low forests.

LACTARIUS UVIDUS Fr. Infrequent, Tolland, Leal. Low ground, under shrubs, etc.

LENTINUS UMBILICATUS Pk. Infrequent. Tolland. On very rotten pine logs.

LEPIOTA AMIANTHINA Fr. Frequent, Tolland, Leal. On debris, under conifers.

LEPTONIA GRISEA Pk. Rare, Tolland. Moist places under fir.

MARASMIUS ANDROSACEUS Fr. Common. Tolland. On beds of pine needles.

Marasmius piceina sp. nov.

Pileus 2–3 mm. broad, membranous, reviving, convex-subexpanded, radiately and widely rugoso-striate, umbilicate, glabrous, "pinkish-buff" (Ridg.). Gills adnate, slightly broad, ventricose, distant, whitish. Stem filiform, equal, short, 1–2

cm. long, pallid with a slight yellowish-buff tint downwards, glabrous, with scarcely any pruina, even, not horny, instititious on half-decayed needles of *Picea Engelmanni*. Odor distinct, penetrating, suballiaceous or somewhat disagreeable. Spores ellipsoid-sublanceolate, acute at one end, hyaline, smooth, 8–10 x 3.5–4 μ. Basidia 4-spored, 30 x 5–6 μ. No cystidia seen.

Tolland, Colorado. Sept. 8. Very abundant on spruce needle beds after rains in the mountain forests. Stem scarcely thicker than a hair.

Marasmius pinastris sp. nov.

Pileus slightly fleshy to submembranous, 1–3 cm. broad, at first campanulate and margin incurved, then expanded-plane, umbonate or papillate, umbo often irregular-uneven, margin at length radiately rugulose-striate to subplicate, surface uneven elsewhere, subtomentose, "snuff-brown" on center to "clay-color" toward margin; flesh thin, equal, whitish. Gills subdecurrent, arcuate, narrow, subdistant, intervenose, crisped, pallid, edge entire. Stem 2.5–4 cm. long, 1–2.5 mm. thick, dilated and pallid at the apex, solid, equal, sometimes striate-lined above, white within, subglabrous above, covered downwards by a distinct roughish "chestnut-brown" tomentum, which is paler on drying, strigose-attached at the base. Odor rather strong, suballiaceous, penetrating. Taste slowly disagreeable or subastringent. Spores 8–9 (10) x 4–4.5 (5) μ, narrowly ovate and pointed at one end, hyaline, smooth. Cystidia absent.

Among needles and debris under pine and spruce. Tolland, Colorado. Sept. 8.

MARASMIUS PRASIOSMUS Fr. Rare. Leal. On decaying twigs of spruce.

MYCENA ALKALINA Fr. Infrequent. Leal. On mosses under spruce and pine.

MYCENA DEBILIS Fr. Frequent. Leal. On mosses under conifers.

MYCENA GALERICULATA Fr. Infrequent. Tolland. On decayed wood.

MYCENA IMMACULATA Pk. Rare. Tolland. On bed of spruce needles.

Mycena parabolica Fr. Infrequent. Tolland. On very rotten and moist coniferous logs.

Mycena pura Fr. Not seen after August. Tolland. On very rotten logs.

Mycena vulgaris Fr. Frequent. Leal. On beds of decaying spruce needles.

Naucoria melinoides Fr. Common. Tolland. Under willows and alders along streams.

Omphalia campanella Fr. Frequent. Tolland. On coniferous logs, etc.

Omphalia epichysium Fr. Infrequent. Tolland. On mossy log of Salix.

Panoeolus campanulatus Fr. Infrequent. Tolland. On horse dung.

Panoeolus retirugis Fr. Common. Tolland. Leal. On dung.

Paxillus involutus Fr. Infrequent. Tolland. On banks.

Paxillus panuoides Fr. Rare. Tolland. On old timbers in the interior of abandoned mines.

Pholiota sp. Rare. Tolland. Growing caespitose in groups of three from the top of a spruce stump; too much dried to permit obtaining a full account of it. Has spores of *P. limonella*, but gills are broader, and it was growing on conifers.

Pholiota discolor Pk. Infrequent. Tolland. On conifer logs.

Pholiota flammans Fr. Infrequent. Tolland. On decayed conifer logs.

Pholiota platyphylla sp. nov.

Pileus submembranous, 1–3 (4) cm. broad, convex, obtuse or obsoletely subumbonate, hygrophanous, "tawny" (Ridg.), disk "mars brown," fading to "antimony-yellow" or "warm-buff," obscurely striatulate on margin when moist, glabrous; flesh very thin on the incurved margin, concolor. Gills broadly adnate, decurrent by tooth, very broad, ventricose, close to almost subdistant, thin, at the very first pallid, soon "clay color" to "buckthorn-brown" (Ridg.). Stem 3–5 (6) cm. long, 2–4.5 mm. thick, equal, or slightly tapering upwards, subflexuous in age,

stuffed, concentrically white-zoned from the delicate veil, zones terminating above middle of stem in a flaring, membranous, whitish annulus, white-scurfy above annulus, becoming at length silky or glabrous below, brownish within and without under the veil remnants, fuscescent. Spores subellipsoid, but narrower toward one end, inequilateral in one view, smooth, 10–12 x 5–6.5 μ, pale rusty brown, cystidia scattered on sides of gills, 60–70 x 9–11 μ, narrowly lanceolate above the slender pedicel, hyaline; sterile cells similar but narrower and crowded.

On wet moss under pine and spruce along stream. Tolland, Colorado. Sept. 5.

PHOLIOTA UNICOLOR (Fl. D.) Fr. Infrequent. Tolland. On decayed wood.

PLEUROTUS BETULINUS (Pk.) (*Panus betulinus* Pk.). Rare. Tolland. Near the ground on the dead limb of a willow.

PLEUROTUS OSTREATUS Fr. Infrequent. Tolland. On stumps or dead trunks of *Abies lasiocarpa*. Spores are white in the mass. There is no doubt that this grows on conifers in this region.

PLUTEUS NANUS Fr. var. LUTESCENS Fr. Not uncommon. Leal. On decayed wood.

PSALLIOTA RUTILESCENS (Pk) emend. (*Bull. Torr. Bot. Club*, 31: 180. 1904.)

Pileus fleshy, 10–15 cm. broad, dry, convex-expanded, firm, whitish when young and fresh, soon becoming "vinaceous-cinnamon" (Ridg.) to drab, with a thick cuticle, the upper thin portion of which at length breaks into small fibrillose cuneate scales; flesh thick, abruptly thin at margin, white at first but slowly changing when cut or bruised to *rufescent-ochraceous*. Gills free, becoming remote, rather narrow, 5–7 mm. broad, narrower behind, crowded, thin, *at first "purplish-vinaceous"* to "*light russet-vinaceous*" (Ridg.), rufescent when bruised, finally "burnt umber" or blackish-brown. Stem stout, 8–12 cm. long, 1.5–3 cm. thick, firm, equal above the rather abrupt, often oblique and spongy bulb, bulb sometimes almost obsolete, sometimes large, elsewhere silky or subfibrillose, glabrescent, *solid*, white at first in and out, *rufescent* where cut or bruised. An-

nulus simple, thin, narrow, persistent, subfragile, white becoming brownish-tinged. Odor aromatic almost of anise or bitter almonds. Spores small, short elliptical-oblong, dark purple-brown, with oil drop, 5–6 x 4–4.5 μ.

Under spruce and fir, often at the base of a tree in humus. Aug. Frequent. Leal. Tolland.

The incomplete description and error in spore size, and the extension of its habitat seem sufficient reasons for a full revised description. As Dr. Peck has remarked, the plants at first appear to fit well to the description so far accessible of the seaside *Psalliota maritimus* Pk., but a more detailed study of the latter in the developing state would doubtless bring out definite discrepancies. It differs from *P. silvatica* Fr. in its solid stem, slightly smaller spores and the narrow annulus.

Psalliota semota Fr. (sense Ricken). Rare. Tolland. Under fir.

Russula adusta Fr. Infrequent. Leal. Under pine.

Russula atroviolacea Burl. Infrequent. Tolland. Under willows. There seems to be a form also in which the stem has a tinge of the same color as the cap.

Russula cyanoxantha Fr. (Form). Rare. Tolland. Under conifers.

Russula delica Fr. Frequent. Tolland. Leal. Under pine in sandy soil.

Russula emetica Fr. Frequent. Leal. Tolland. In mixed forest on very rotten wood.

Russula fallax Cke. Infrequent. Tolland. Mossy places.

Russula flava Romell. Common. Tolland. Under pine and spruce.

Russula graminicolor Quel. Infrequent. Tolland. Leal. Under pine and spruce.

Russula maxima Burl. Rare. Tolland. Under spruce.

Russula modesta Pk. Rare. Tolland. Under *Abies lasiocarpa* at an elevation of 9800 feet, growing on the bare ground.

Russula nigrodisca Pk. Frequent. Tolland. On moist places under spruce.

Russula nigricans Fr. Infrequent. Tolland. Under conifers.

Russula puellaris Fr. Infrequent. Leal. Under thickets in open moist places.

Russula roseipes Secr.-Bres. Infrequent. Tolland. Leal. On moist ground under conifers.

Russula rugulosa Pk. Infrequent. Leal. On mosses under conifers.

Russula sanguinea Fr. Frequent. Tolland. Under spruce.

Russula serissima Pk. Infrequent. Tolland. Under conifers on high slopes.

Russula subalutacea Burl. Rather frequent. Tolland. Under spruce.

Russula virescens Fr. Infrequent. Tolland. Mixed woods.

Stropharia depilata Fr. Scattered. Tolland. Leal. Under conifers.

Stropharia semiglobata Fr. Frequent. Tolland. On dung.

Stropharia squamosa var. **subalpina** var. nov. Infrequent. Tolland. On forest debris or humous soil in coniferous forests.

With the data on its variability incomplete, this is retained here as a variety, although it is definitely distinct from the foregoing species and its several varieties. The spores are elongated-elliptical, smooth, obtuse, 12–15 (16) x 5.5–6.5 (7) μ, pale-purplish in microscope. Pileus 3–7 cm. broad, "yellow-ochre" to "ochraceous-orange" (Ridg.), becoming tawny in age, glabrescent, viscid, soon dry. Gills broad, at first "drab-gray" then "storm-gray" (Ridg.); stem 4–10 cm. long, 4–8 mm. thick, white at first, as are the lacerate, spreading or recurved scales, but lutescent to fuscescent.

It differs, then, according to the notices of the European authors as to spore size, from *S. squamosa* by its large spores, from the var. *thrausta* by lack of the hygrophanous flesh and probably by its spores. Massee, who must have had access to Cooke's var. *aurantiacus*, gives its spores like that of *S. squamosa*.

Tricholoma bufonium Fr. Rare. Tolland. Under spruce, alder, etc.

TRICHOLOMA CONGLOBATUM Fr. Rare. Tolland. Under pine.

TRICHOLOMA EQUESTRE Fr. Infrequent. Under pine.

TRICHOLOMA FALLAX Pk. Infrequent. Tolland. On conifer needles.

TRICHOLOMA IMBRICATUM Fr. Frequent. Under pines.

TRICHOLOMA MURINACEUM Fr. Infrequent. Leal. Under spruce and fir.

TRICHOLOMA PANOEOLUM var. CAESPITOSUM Bres. Infrequent. Under conifers. Tolland.

TRICHOLOMA PERSONATUM Fr. Infrequent. Tolland. Under poplars.

TRICHOLOMA PESSUNDATUM Fr. Common. Under pines.

This is the first American collection I have seen of this species, but I have no doubt of its identity.

TRICHOLOMA PORTENTOSUM Fr. Infrequent. Under pine.

TRICHOLOMA RUTILANS Fr. Infrequent. Tolland. Leal. On pine stumps and logs.

TRICHOLOMA SAPONACEUM Fr. Infrequent. Tolland. Under spruce and pine.

Tricholoma tristiforme sp. nov.

Pileus fleshy, 1–2 cm. broad, convex, then expanded-plane, obtuse, sometimes papillate, dry, covered with floccose-fibrillose, pointed or recurved, minute, fuscous to blackish scales, denser on disk, ground color "tileul-buff" (Ridg.), margin not striate; flesh white, unchanged. Gills emarginate-adnate, broad, broader in front, ventricose, close, white, scarcely cinerescent, edge entire. Stem 2–3 cm. long, 1.5–3 mm. thick, equal, solid, innately and longitudinally silky-fibrillose, white scarcely changing, subshining when dry. Cortina slight and evanescent, perhaps lacking. Odor and taste subfarinaceous. Spores 7–9 x 4–5 μ, narrowly elliptic to oblong, hyaline, smooth, granular within. Basidia 48–50 x 5 μ, 4-spored, cystidia none. Sterile cells on edge of gills subfiliform, short and indistinct.

On the ground under lodge-pole pine. Tolland. Aug. 24.

In size, habit and appearance this resembles an Inocybe. It differs from *T. triste* Fr. in its solid stem and indistinct cortina, and probably in its spores.

GASTEROMYCETES

Geaster coronatus (Schaeff.) Schroet. Tolland.

Geaster schmidelii Vitt. Tolland.

Calvatia fontanesii Mont. Tolland.

Lycoperdon gemmatum Fr. Leal. Tolland.

Lycoperdon glabellum Pk. Leal. Tolland.

Lycoperdon nigrescens Pers. Tolland.

Lycoperdon pyriforme Fr. Leal. Tolland.

Bovista plumbea Fr. Leal.

Crucibulum vulgare Tul. Leal. Tolland.

Common on wood and debris. One collection was found on cow dung.

Sphaerobolus carpobolus L. Leal. Tolland.

Common on debris of wood, etc. One collection on cow dung, and one on a spruce cone lying on the ground.

University of Michigan

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PLATE XXX

Helvella albipes Fkl.

Tolland, Colorado, Sept. 20, 1920
Elevation 9,000 feet. (Photo. Baxter)

PLATE XXXI

HELVELLA INFULA FR.

Tolland, Colorado, Sept., 1921. (Photo. Baxter)

PLATE XXXII

Gyromitra esculenta Fr.

Port Huron, Michigan, May 1, 1921.
Collected under pine by Mr. Howe. Contributed by Dr. O. E. Fisher.

PLATE XXXIII

HYDNUM SUAVEOLENS FR.
Tolland, Colorado, Sept. 4, 1920. (Photo. Baxter)

PLATE XXXIV

Polyporus confluens Fr.

Tolland, Colorado, Sept. 2, 1920. (Photo Baxter.)

NOTES ON A BUD-SPORT OF *HIBISCUS MUTABILIS* L.[1]

CARL D. LA RUE

In 1918 the writer discovered a bud-sport of *Hibiscus mutabilis*, which he planned to keep under observation for a considerable period of time. After a little more than two years, however, the observations were terminated by the author's return to America. Such data as were obtained during this period are published here for comparison with the results of more complete investigations made elsewhere.

Hibiscus mutabilis is very common as an ornamental shrub throughout the eastern tropics. In Sumatra the double-flowered forms of both variety *alba* and variety *rosea* are found in the yard of almost every house. In the autumn of 1917, a number of cuttings for ornamental plantings were made from bushes of the double-flowered variety *alba*, and these were placed in a nursery under the author's supervision.

Most of these were removed when they were well rooted, but a few were left in the nursery. These grew very rapidly and in the spring of 1918 began to blossom. All were true to the parent type, but later one of them developed one branch which bore only pink flowers exactly like those of variety *rosea*.

[1] There has been some doubt in the author's mind whether the plant considered in this paper is really *Hibiscus mutabilis* L., the flowers of which are said to be white when they first open, but turn pink during the first day. The plant in question does not show this change, but otherwise it agrees with the description of *H. mutabilis* L. In leaf and stem characters it is exactly like plants of *H. mutabilis* which the author saw in the "Bergtuin" at Tjibodas, Java. Unfortunately, these plants were of the pink variety and therefore showed no change of color.

In a recent letter Mr. I. H. Burkill, director of the Singapore Botanic Gardens, states that *H. mutabilis*, as grown in the Singapore Gardens, shows the characteristic color change, but that *H. mutabilis* var. *alba* does not show any such change. From this it appears that the plant in question is *H. mutabilis* var. *alba*.

Since the plant in question had been grown from a cutting by the writer, there was no possibility of its being due to a graft of any sort, and therefore no doubt that it was a true bud-sport.

An attempt was made to determine the genetic relationship of the bud-sport to the parent bush, but this failed because, although the ovules appeared to be normal, the pollen of both the pink-flowered bud-sport and the white-flowered parent was abortive. Further examination failed to show any viable pollen of either variety from any of the plants of the surrounding region. The single-flowered form may have viable pollen, but no plants of this type could be found. According to Firminger [2] the single-flowered type is hardly worthy of cultivation, and this doubtless accounts for its rarity.

Although all hope of crossing the plants had to be given up, the bush was still kept under observation to see whether it would produce other mutations of a similar sort. This observation ceased at the end of June, 1920. Till that time no further mutations had been observed on the parent bush. During most of this time, however, the bush was kept cut back rather closely; all of its branches were used for cuttings as soon as they became large enough. Shortly after it was found that pollination was impossible, the mutant branch was cut back rather closely, and from this four cuttings were made. Although in general this species, like most other species of Hibiscus, is grown from cuttings with extreme ease, the mutant branch appeared to be rather weak and only two of the cuttings survived. The branch failed to sprout again and soon died back to the parent stem. The two daughter plants grew slowly, but finally each produced a number of branches which developed flowers. All of these were of the double pink variety.

At the time when the mutant branch was cut back, all the other branches of the parent bush were trimmed also, and as many cuttings as possible were made. When the branches again grew out, another set of cuttings was made and this was continued. In all, about 250 cuttings were made from these white-

[2] Firminger's *Manual of Gardening* (fourth edition), revised by H. St. John Jackson, Thacker, Spink and Co., Calcutta, 1890.

flowered branches, of which 161 had flowered before the writer left Sumatra. In one of these bushes a duplication of the original mutation was found. One branch was produced which bore only double pink flowers. All the other branches bore white flowers.

Another bush showed a mutation in the form of a sectorial chimaera. About one third of the branch bore only pink flowers, while the remainder produced only white flowers. When a flower bud developed on the line of junction of the two regions, part of it was white and part pink. The line of demarcation in the flower was very sharp and very frequently divided petals, with one part of a petal pink and the remainder white. The line of demarcation ran, of course, from tip to base of the petal. The pink and the white sectors appeared, from the flowers they bore, to run straight up the branch from base to tip and not to twist around the axis.

Still another bush, which bore only white flowers, showed a rather complicated variegation of the leaves. One part bore only green leaves, another part bore only yellow ones, while the leaves on the remainder of the plant were variegated. Of these variegated leaves, some had yellow sectors, and the remainder of the leaf was green, but most of them were irregularly mottled with spots ranging from yellow to normal green in color. There appeared to be four different shades of leaf color from the yellow spots without chlorophyll, to the spots with the full amount of chlorenchyma. The variegation was extremely irregular so that no one type could be identified with any particular segment of stem. The variegated bush, like the mutant pink-flowered form, was noticeably weaker than the normal green form.

If the 161 plants grown in this study give any indication, it seems that bud-sports are relatively common in this species. Here they occurred at the rate of about one to every fifty normal plants. It is doubtful whether they are usually so frequent. A great many, probably several hundred, other plants of unknown history were observed in Sumatra and Java, but none were found bearing mutant branches. The variegated form probably does not often arise, since it was never found growing

elsewhere and it might be supposed that if it occurred often, it would occasionally be propagated as a curiosity.

Whether or not the pink-flowered bud-sport represents a reversion to an ancestral form can only be conjectured. The writer has been unable to discover any data on the relative age of the two forms. Both of them are probably ancient.

University of Michigan

NOTES ON INTERESTING PLANTS OF MICHIGAN

W. L. McATEE

These notes are chiefly from Professor Charles Fay Wheeler's interleaved copy of *Michigan Flora.* The writer is fortunate in possessing certain items from the library of that beloved botanist,[1] among which are copiously annotated copies of *Michigan Flora*[2] and *Additions to the Michigan Flora since 1892.*[3] The volume contains inserted printed articles on Michigan plants, a few specimens and original labels, manuscript lists for various localities, and a number of letters, of which the most interesting one is from Professor Thos. C. Porter, the revered Pennsylvania botanist. With the kind permission of Dr. W. J. Beal, this letter is herewith reproduced verbatim:

LAFAYETTE COLLEGE,
EASTON, PENN.,
Aug. 1, '92.

MY DEAR PROF. BEAL:

I have received the copy of the *Flora of Michigan,* prepared by you and your associate, Mr. Wheeler, and return my best thanks. The work is well done. My regret is that you did not make known to me beforehand what you intended to do, because I could have furnished an amount of additional material.

In the year 1865, in company with Messrs. Chas. E. and Aubrey H. Smith and Dr. Joseph Leidy, I visited the Lake

[1] For an appreciative sketch of Prof. Wheeler's career, see W. F. Wight, *Science, N. S.,* 32: 72–75.

[2] *Thirtieth Annual Report of the State Board of Agriculture of the State of Michigan,* 471–640. 1891.

[3] *Thirty-seventh Annual Report of the State Board of Agriculture of the State of Michigan,* 82–91 (1897–98) 1899.

Superior region and collected largely and noted all the species of plants observed. It was my purpose to publish a list which I had prepared. Dr. Robbins proposed to make it a joint affair. For certain reasons, which I need not give, the printing was delayed from time to time and it has not yet seen the light. It may be that, even at this late day, I shall write up and publish an account of the expedition. At all events a brief statement of the results may be of use to you.

The following species are not contained in your *Flora:*
Stellaria borealis Big. — S. Ste. Marie.
Thalictrum polygamum Muhl. — S. Ste. Marie.
Geranium columbinum L. — Grand Detour.
Lythrum salicaria L. — Detroit.
Calamagrostis confinis Nutt. — Flint, *Dr. Clark.*
Calamagrostis Langsdorffii — Isle Royale.
Isoetes lacustris L. — S. Ste. Marie, head of ship-canal. See Englemann's Monograph.

These plants are in our Herb., but I am sorry I have no duplicates to send you.

I will now jot down lists of some of the rarer species with localities and dates:

DETROIT IN THE CEMETERY. — July 19, 65.
Lythrum salicaria L.
Scirpus lineatus Mx.

SAULT DE STE. MARIE. — July 21–29, 65.
Adenocaulon bicolor Hook. — 6 miles S.W. of the town.
Pyrola minor L.
Listera convallarioides Nutt. — Abundant.
Spiranthes Romanzoffiana Cham. — This is the *S. cernua* of Hooker's *Flora B. Am.* We saw at once that it was very different from our *S. cernua,* and on my return home I made a full critical examination and comparison of the two species,

and sent specimens and notes to Dr. Gray, which led him to refer the northern one to *S. Romanzoffiana*.

Habenaria hyperborea R. Br. — Abundant.

Habenaria psycodes Gray. — Abundant.

Avena Smithii Porter. — In woods, 6 m. S. W.

Phleum alpinum L.

Isoetes lacustris L. — Found by Dr. Leidy and myself at the head of the ship-canal and therefore in Michigan.

ONTONAGON. — July 31.

Prunus pumila L.

Ammophila arundinacea Aut.

From Ontonagon, our steamer crossed in the night to Thunder Bay and went to Ft. William, Canada, returned and doubled Thunder Cape, ran up the N. W. flank of Isle Royale and doubled the reefs of trap-rocks, and came down on the S. E. side into the natural canal formed by a sunken chain of trap-rocks on the one side, the emerged summits making a line of islets, mostly covered with storm-beaten balsam-firs, and on the other, by the mainland, the channel 3 or 400 yards wide and very deep. Proceeding down this channel 8 miles, we reached Copper Harbor, a deserted mining village, and tied the vessel by hawsers to trees on the shore. Thus ended that day. Very early next morning I was up and found a yawl at the stern into which ladies and gentlemen were getting down and I volunteered thinking they would put me on the shore a rod or two off, but instead of heeding my request they pushed off to Caribou Islet, one of the islets across the channel, to hunt *chlorastcrolites*. I was rewarded by finding on that lonely spot, besides some of the gems, the following plants:

CARIBOU ISLET. — Aug. 2, 65.

Anemone multifida D. C.

Sagina nodosa Fenzl.

Barbarea vulgaris R. Br. — Very vigorous, growing in shallow water and evidently native.

Erigeron acris L. v. Droebach. Blytt.
Campanula rotundifolia L. v. arctica.
Lilium philadelphicum L. with 5 flowers!!
Poa alpina L.
Junip. Sabina L. v. procumbens Ph. — Covering the rocks.

After breakfast A. H. Smith and I took to the mainland where there was a clearing and a sphagnum swamp partly overrun by fire. There we had wonderful success and came back at 12:30 P.M. laden with spoils. At 1 the steamer left her moorings and passing the inlet near the lighthouse, steered for Eagle River on Keweenaw Point.

Isle Royale. — Mainland. — Aug. 2, 65.

Corydalis aurea Willd.
Geranium Carolinianum L.
Rubus Nutkanus Moc.
Drosera intermedia var.
Lonicera hirsuta Eaton.
Phacelia Franklinii Gray.
Castilleia pallida v. sept.
Utricularia cornuta Mx.
Comandra livida Richds.
Calypso borealis in fl.
Habenaria dilatata Gr.
Habenaria hyperborea R. Br.
Habenaria psycodes L.
Eriophorum alpinum L.
Carex livida Willd.
Carex Houghtonii Torr.
Calamagrostis stricta Trin.
Calamagrostis Lapponica Trin.
Calamagrostis Langsdorffii Trin.
Cryptogramme acrostichoides.
Aspidium fragrans Swtz.

PORTAGE RIVER. — Aug. 3, 65.
Erigeron acris L. v. Drbn.
Carex (flexilis) castanea Wah.
Carex (ampullacea) utriculata v. minor.
Carex oligosperma Mx.

MARQUETTE. — Aug. 4, 65.
Pinus Banksiana.
Trisetum molle v. subspic.

MTH. OF CARP RIVER. — Aug. 4, 65.
Aster umbell. v. pubens.
Goodyera Menziesii.
Elymus Sibiricus L., var.
Equisetum scirpoides.

GRAND DETOUR. — Aug. 5, 65.
Hypericum Kalm.
Lathyrus maritimus.
Drosera linearis.
Solidago Ohioensis.
Primula Mistassinica.
Halenia deflexa.
Graphephorum melic.
Selaginella spinosa.

These are some of the spoils obtained. Excuse the hasty manner in which I have written under pressure and believe me

Yours very truly,

THOS. C. PORTER.

From other letters inserted in this interesting copy of the *Michigan Flora*, from marginal notes and other sources (including collections by the writer), have been gleaned the following notes. Only those relating to comparatively little known plants or those new to the state list are reproduced. The source

of information is given in each case, and the authority, unless otherwise stated, is C. F. Wheeler. Twenty of the plants, it appears, have not yet been included in catalogs of the Michigan flora. These have been indicated by an asterisk (*).

POLYPODIACEAE

Woodsia oregana D. C. Eaton.—Lower falls of Menominee River, Sept. 1892, C. F. Wheeler. Note on interleaf.

Asplenium platyneuron L.—Prof. Bailey collected this species in Barry Co. Marginal Note.—*Flora* gives Allegan as only known station.

ALISMACEAE

Lophotocarpus calycinus (Engelm.) J. G. Smith.—Grand Rapids; J. G. Smith.[4] *Additions*, p. 10.

GRAMINEAE

Paspalum setaceum Mchx.—Lansing, C. F. Wheeler. *Additions*, p. 11.

Syntherisma filiforme L.—Agricultural College, Dr. W. J. Beal. *Additions*, p. 11.

*Briza maxima L.—Manistee, July 1900, streets; also Grand Rapids, June, 1899, streets. F. P. Daniels, in letter.

Bromus sterilis L.—Lansing. *Additions*, p. 12.

CYPERACEAE

Rhynchospora fusca L.—Charlevoix, beach of Long Lake, Sept. 6, 1892; Thunder Bay Id., 1895; note on interleaf.

*Scirpus heterochaetus Chase.—Arbutus Lake, Grand Traverse Co., Aug. 23, 1919. W. L. McAtee.

Carex brunnescens Pers.—Alpena. Note on interleaf.

Carex castanea Wahl.—Portage River, Aug. 3, 1865. Thos. C. Porter, letter of Aug. 1, 1892.

[4] Separate from *11th Ann. Rep. Mo. Bot. Garden*, p. 3. Sept. 27, 1899.

LILIACEAE

ALLIUM VINEALE L. — Experiment Station at South Haven, April 19, 1901, C. F. W. Note on margin of *Additions*.

MEDEOLA VIRGINIANA L. — Escanaba, R. E. Morrell. *Flora* gives Gaylord as probable northern limit. Inserted note.

*LILIUM TIGRINUM Andr. — Manistee, Aug. 1900, spontaneous in neglected part of cemetery. F. P. Daniels, in letter.

CHENOPODIACEAE

KOCHIA SCOPARIA L. — Grand Rapids, 1899 introduced, Miss A. Brook. Note on interleaf.

AMARANTHACEAE

AMARANTHUS HYBRIDUS L. — Ionia, June 1896, Grand River bottoms. Compared at Harvard Herbarium. F. P. Daniels, in letter.

CARYOPHYLLACEAE

*LYCHNIS DRUMMONDII Hook. — Niles, R. Ballard. In letter.

RANUNCULACEAE

ATRAGENE AMERICANA Sims. — Iron Mt., Mich., S. S. Brewster, letter of Jan. 24, 1898.

THALICTRUM POLYGAMUM Muhl. — Sault Ste. Marie, July 21–29, 1865, Thos. C. Porter. Letter of Aug. 1, 1892.

PAPAVERACEAE

*GLAUCIUM GLAUCIUM L. — Park Id., Les Cheneaux Ids., W. C. Coryill. Letter of March 12, 1894.

FUMARIACEAE

BICUCULLA CUCULLARIA L. — B. CANADENSIS Goldie. — Escanaba, Mrs. J. M. Millar, letter of May 23, 1896. *Flora* gives Frankfort as northern limit of both species.

FUMARIA OFFICINALIS L. — Manistee, June 1900, yards, escaped. F. P. Daniels, in letter.

CRUCIFERAE

BERTEROA INCANA L. — Roadside southeast of Traverse City, Sept. 2, 1919, W. L. McAtee.

CAPPARIDACEAE

CLEOME SERRULATA Pursh. — Grand Rapids, 1901, Rev. J. W. Stacey. Note on interleaf.

*ROSA VILLOSA L. — Escaped south of Brighton, June 1, 1898, Wheeler and Longyear. Original herbarium label.

AMELANCHIER SANGUINEA Pursh. — According to Wiegand's treatment, this appears to be a common species of the jack pine plains. Collected in Crawford Co., Aug. 29–31, and in Grand Traverse Co., Sept. 2; in both instances with a little fruit still hanging. W. L. McAtee.

CRATAEGUS BRACKWAYAE Sargent. — Thunder Bay Id., C. F. W., *Additions*, as *C. douglasii* Lindley. *C. brackwayae* is a synonym, according to W. W. Eggleston.

OXALIDACEAE

ZANTHOXALIS CORNICULATA L. var. DILLENII Jacq. — Ionia, June 1896, roadsides. Compared at Harvard Herbarium, F. P. Daniels, in letter.

LINACEAE

CATHARTOLINUM SULCATUM Riddell. — Plainfield, Aug. 1896, Miss E. J. Cole. Note on interleaf.

RUTACEAE

PTELEA TRIFOLIATA L. var. TOMENTOSA Raf. — Saugatuck, Wheeler, *Additions*, p. 5.

EUPHORBIACEAE

TITHYMALUS OBTUSATUS Pursh. — Wayne Co., not common. Notes by A. F. Foerste?

VITACEAE

VITIS LABRUSCA L. — Niles, R. Ballard, in letter.

LYTHRACEAE

*ROTALA RAMOSIOR L. — Alto, Aug. 1901, Rev. F. P. Daniels, note on interleaf.

ONAGRACEAE

OENOTHERA MURICATA L. — Detroit, common along roads. Notes by A. F. Foerste?; also reported by Gleason, A. H., *Mich. Ac. Sc.*, 1913, p. 148.

*EULOPHUS AMERICANUS Nuttall. — Ionia, Aug. 1896, Sept. 1897, Grand River bottoms, eastern township; compared at Harvard Herbarium. Gray considered this one of the rarest of American plants. F. P. Daniels, in letter.

ERICACEAE

*ANDROMEDA GLAUCOPHYLLA Link. — Mud Lake, Grand Traverse Co., Aug. 26, 1919, W. L. M. This is the form with fine pubescence on under side of leaf; doubtfully distinct from *A. polifolia* L.

VACCINIUM ATROCOCCUM A. Gray. — Saddle-bag Swamp, 1898, Miss E. J. Cole. Note on interleaf.

VACCINIUM OVALIFOLIUM J. E. Smith. — Boardman Plains, Grand Traverse Co., Mich., Sept. 2, 1919, in fruit, W. L. McAtee.

OLEACEAE

*LIGUSTRUM VULGARE L. — Woods near the Agricultural College. *Additions*, p. 8.

CONVOLVULACEAE

*Quamoclit coccinea L.—Grand Rapids, Mich., Miss E. J. Cole. Note on interleaf and specimen.

BORAGINACEAE

Myosotis laxa Lehm. — Campus of the Agricultural College, *Additions*, p. 8.

LABIATAE

*Koellia verticillatum Michx. — Twin Lake, Muskegon Co., June 26, 1900, C. F. Wheeler, MS. note in *Additions*.

Lycopus europaeus L. — Around elevators and along streets of Port Huron, C. K. Dodge. *Additions*, p. 9.

SOLANACEAE

*Solanum torreyi A. Gray. — Niles, railroad embankment, spreading rapidly. R. Ballard, in letter.

SCROPHULARIACEAE

Agalinis paupercula A. Gray. — Escanaba, Mrs. J. M. Miller. Inserted note. *Flora* gives Lower Peninsula.

Euphrasia canadensis Townsend. — Isle Royale, W. A. Wheeler. Note on interleaf.

BIGNONIACEAE

*Catalpa catalpa L. — Sturgis, Sept., 1898, spontaneous seedlings of considerable size. Is this the basis of *C. speciosa* record in *Flora?* F. P. Daniels, in letter.

PLANTAGINACEAE

Plantago aristata Michx. — Gowen, Oct. 10, 1897, J. L. Hunter. Note on interleaf.

CICHORIACEAE

*HIERACIUM AURANTIACUM L. — Grand Rapids, June 10, 1901, Miss E. J. Cole. MS. note in the *Additions*.

PICRIS HIERACIOIDES L. — Upper Manistee River, Crawford Co., Aug. 29–31, 1919, W. L. McAtee. Common on plains here and in Grand Traverse County.

AMBROSIACEAE

XANTHIUM SPINOSUM L. — Bay View, C. W. Fallass. *Additions*, p. 7.

CARDUACEAE

*SOLIDAGO PUBERULA Nuttall. — Upper Manistee River, Crawford Co., Aug. 29–31, 1919, W. L. McAtee. This record represents a great extension in range of this species, but is in harmony with the distribution of numerous species, chiefly Atlantic in range, which are also found in the Great Lakes region. The specimen collected is glabrous, but otherwise agrees with *puberula;* certainly is closer to that than to any other species.

EUTHAMIA TENUIFOLIA Pursh. — Pine Id., Lake, Plainfield, Miss E. J. Cole, 1896. Note on inserted slip.

ERIGERON ACRIS L. var. DROEBACHIANUS Retz. — Caribou Islet, Aug. 2, 1865. Thos. C. Porter. Letter of Aug. 1, 1892.

ANTENNARIA FALLAX Greene. — Shores of Grand Traverse Bay, four miles north of Traverse City, C. F. Wheeler. *Additions*, p. 7.

ANTENNARIA PARLINII Fernald. — Oak Woods between Brighton and Hamburg, Wheeler and Longyear. *Additions*, p. 7.

RUDBECKIA TRILOBA L. — Common along shores of Thunder Bay, appears to be a native. C. F. Wheeler. Note on interleaf.

*XIMENESIA ENCELIOIDES Cav. — Grand Rapids, Oct. 8, 1892, Miss Emma G. Cole. Note on interleaf.

ADENOCAULON BICOLOR Hooker. Sault Ste. Marie, 6 miles S.W., July 21, 29, 1865. Thos. C. Porter. Letter of Aug. 1, 1892.

*CENTAUREA SOLSTITIALIS L. — Farwell, Mich. 1901. MS. note in *Additions.*

BIOLOGICAL SURVEY
U. S. DEPT. OF AGRICULTURE
WASHINGTON, D. C.

DISTRIBUTION OF THE VIOLACEAE OF MICHIGAN

BERTHA E. THOMPSON

From the standpoint of specific identification, the violets are a very difficult group. This fact is not recognized until a critical study is made of them. This brings out multitudes of variations with a corresponding multiplicity of names, which are given oftentimes to variations due only to differences in seasonal growth or to conditions of environment.

In this paper a careful study has been made of nearly all the available herbarium material, including that in the Michigan Agricultural College, the University of Michigan (where are the C. K. Dodge collections), and the collections of Cecil Billington of Detroit. Most of the Dodge specimens have been identified by Kenneth K. Williams of New York and F. F. Forbes of Brookline, Mass. Collections marked with the asterisk, dagger, or double dagger (* † ‡) were determined by Brainerd, McKenzie and Forbes, respectively.

Plants have been studied in their native habitat, both in the flowering stage and in the late-summer stage. They were staked while in flower and studied later. In addition, nearly all of the species occurring in the vicinity of East Lansing were transplanted to a plot on the college campus. Some specimens were obtained from Calhoun County and other places. The observations of growing plants covered a period of three years. Transplanting to a plot has certain advantages over study in the field. In the latter case the stakes are likely to be pulled up by the idle or curious.

Many of our violet species show a tendency to intergrade or hybridize, and the resulting plants do not agree at all with the species described in Gray's *Manual*, or Britton and Brown's *Illustrated Flora*.

As summer advances, in many species the early or vernal leaves increase in size and change in shape, thus often making

it exceedingly difficult to recognize the same violet that was known in the vernal flowering stage. Some violets die down in summer and revive in autumn with an entirely different appearance of flower, foliage, and fruit. The seasonal forms appear like two different species. *Viola rotundifolia* is an example.

There are a few species which intergrade so repeatedly that it is very hard to distinguish clearly the specific types from the hybrids. *Viola sororia* and *Viola papilionacea* are such species. The pubescence of the one intergrades with the smoothness of the other, and the leaves change in shape as they hybridize. The specific differences are noted in the descriptions of species. *Viola blanda* and *Viola pallens* are also very closely allied.

In 1881, C. F. Wheeler and Erwin F. Smith compiled a catalog of Michigan plants, in which is given a list of sixteen violets. Dr. W. J. Beal and C. F. Wheeler prepared in 1892 a catalog, published in the *Thirteenth Report of the Secretary of the State Board of Agriculture*, in which they list sixteen species, practically the same list as that given by Wheeler and Smith. In the *Michigan Flora* of 1904, Dr. Beal gives a list of thirty species, in which he has apparently accepted many of Dr. Greene's new species.

Dr. Greene, of the U.S. National Herbarium, did a great deal of work on the violets of the prairie states. Apparently he based his classification of species on the minute characteristics as seen in the individual collections at certain seasons of the year. It is barely possible that some of his species are seasonal or regional variations of other species. Dr. Greene named many species which are not recognized by other violet specialists.

Dr. Ezra Brainerd of Middlebury, Vermont, who has watched the seasonal and regional variations of species from all parts of the country, recognizes many forms as variations rather than as separate species. He has studied them in his own garden collection for many years. His assistance in the identification of some species for this study is greatly appreciated.

On account of the critical nature of the genus, it was thought best to include in the distribution records only those specimens

which have been actually examined. It is believed that those who have made lists of plants from various parts of the state will see the justice of this. The county has been made the unit of location.

In the key which follows, an attempt has been made to use points of structure which occur at the time of petaliferous flowering. These can be used in one season for identification without waiting for the late summer characteristics. A serious difficulty confronts an amateur when he wishes to learn what species he has in flower, if a part of the key depends upon a knowledge of the cleistogamous flowers. This is also most keenly felt in teaching classes.

The work of this paper was begun at the suggestion of Professor H. T. Darlington, to whom I am greatly indebted for many helpful directions and suggestions. To Dr. Ezra Brainerd I am very grateful for assistance in identification of difficult species and for references. I appreciate also the encouragement given by Dr. E. A. Bessey during the entire study.

FAMILY VIOLACEAE (Violet Family)

Herbs with rootstocks or runners; leaves alternate or basal; sepals 5, equal or unequal; petaliferous flowers with an irregular 1-spurred corolla of 5 petals; 5 stamens, 2 of which have appendages extending down into the spur; anthers adnate with the filaments; connective extending beyond, enclosing the style; pistil a 1-celled, 3-valved capsule with 3 parietal placentae, splitting on the midrib or septicidally. Style club-shaped or beaked. Seeds with hard seed coat; embryo straight.

Sepals not auricled; petals equal in length; stamens united in a sheath .... 1. Cubelium.
Sepals auricled except in *V. eriocarpa;* lower petal spurred; stamens distinct, the two lower spurred .... 2. Viola.

1. CUBELIUM Raf. (Green Violet)

Perennial leafy herbs with 1–3 greenish white axillary flowers; sepals 5, linear, equal. Petals nearly equal, lower one larger and

saccate at the base; stamens 5, united in a sheath with a 2-lobed gland at the base. Style hooked at the apex. Capsule 3-valved.

1. CUBELIUM CONCOLOR (Forst.) Raf.

Simple leafy stem, pubescent. Leaves alternate, nearly entire, pointed at both ends. Flowers axillary in recurved pedicels

Specimens examined. — Ingham Co. 1872, collector not given; Kent Co., Miss E. J. Cole.

2. VIOLA Tourn. (VIOLET)

Plants stemless or with leafy stems. Petals unequal, with lower one spurred. Stamens cohering around the ovary; the two lower bearing spurs which extend into the corolla spur.

Following these are the cleistogamous flowers without petals, which are fertilized in the bud and bear abundant seeds. These are borne on shorter peduncles concealed by leaves, or on the surface of the ground. Closely allied species hybridize freely and produce many confusing forms.

KEY TO MICHIGAN SPECIES

* Stemless plants, the leaves and scapes from a rootstock or from runners 1

1*a*. Corolla yellow; leaves orbicular ....22. *V. rotundifolia*.

1*b*. Corolla not yellow 2

2*a*. Rootstock thick, fleshy, without runners 3

3*a*. Plants essentially glabrous 4

4*a*. Leaf-blades narrowly lobed or cut; rootstock short, erect............................1. *V. pedata*.

4*b*. Leaf-blades not lobed 5

5*a*. Corolla violet; spurred petal more or less villous; beard of lateral petals not strongly knobbed.

Corolla violet with white base, sepals 6–8 mm. long, narrow, acute, distinctly 2-nerved; leaves (early) with narrow sinus, the angle of which is less than 90°; capsule usually purple-dotted; peduncles with green bracts near center; seeds normally buff....................9. *V. affinis*.

Corolla violet; sepals 3–4 mm. long, obtuse; leaves slightly reniform; angle of the sinus widely spreading; capsules green; seeds olive-brown....10. *V. nephrophylla.*

5*b*. Corolla violet, white or greenish-yellow at base; spurred petal glabrous.

Corolla deep violet, white or green-yellow at the base; sepals acute, with scarious margins, sometimes ciliolate; beard of lateral petals not strongly knobbed; seeds 2 mm. long, dark brown; cleistogamous flowers on short horizontal peduncles ....3. *V. papilionacea.*

Corolla violet-blue, darker colored in the throat; sepals obtuse, entire, with green margins; beard of lateral petals strongly knobbed or clavate; seeds 1.5 mm. long, nearly black; cleistogamous peduncles long and slender...............11. *V. cucullata.*

3*b*. Plants more or less pubescent 6

6*a*. Leaves lobed, parted, or slightly incised at the base 7

7*a*. Leaves palmately 5–11 lobed; outline ovate 2. *V. palmata.*

7*b*. Leaves slightly lobed, or incised at the base.

Leaves lanceolate, sagittately cut at the base, often ciliate............13. *V. sagittata.*

Leaves not lanceolate.

Leaves ovate-oblong, finely pubescent, sharply toothed at the base .12. *V. fimbriatula.*

Leaves broadly ovate, deltoid, coarsely toothed at the base........14. *V. emarginata.*

6*b*. Leaves not lobed, orbicular to reniform

8*a*. Spurred petal villous 9

9*a*. Upper surface of leaves hirsutulous, often appressed to ground; flowers reddish-purple.........................6. *V. hirsutula.*

9*b*. Lower surface of leaves and petioles pubescent.

Sepals and auricles ciliate......7. *V. septentrionalis.*

Sepals and auricles not ciliate. ..8. *V. novae-angliae.*

8*b*. Spurred petal not villous, blades ovate.
Corolla violet, lavender, or white; leaves and petioles pubescent; seeds brown. Intergrades with *V. papilionacea*..................4. *V. sororia.*

Corolla striped with blue and white; leaves and petioles pubescent when young, smooth when old.........................5. *V. sororia* x *triloba.*

2*b*. Rootstocks long and filiform, with runners 10
10*a*. Corolla white with dark lines on the lower petal; leaves, if cordate, with open sinus 11

11*a*. Lateral petals bearded (only rudimentary hairs in *V. pallens*) 12
12*a*. Leaves ovate-cordate; apex acute; scapes usually as tall as the leaves.
Leaves and petioles pubescent when young; upper surface smooth or with hairs when old; numerous filiform runners; sinus quite open, more than 90° and larger than *V. renifolia;* seeds obtuse at the base, smooth, 2mm. long 17. *V. incognita.*

Leaves and petioles nearly glabrous or with scattered hairs; sinus wide-spreading................18. *V. incognita* var. *forbesii.*

12*b*. Leaves broadly ovate-cordate; apex rounded; glabrous on both sides; petioles and scapes with scattered hairs; lateral petals with a few rudimentary hairs or none; flowers small; upper petals broadly obovate; seeds 1 mm. long, almost black; in moister soil than *V. blanda*............................20. *V. pallens.*

11*b*. Lateral petals beardless (see also *V. pallens*) 13
13*a*. Leaves reniform, rounded at the apex; sinus 1/3 to 1/4 the length of leaves, often rather narrow; runners rarely present, very short, raceme-like, bearing cleistogamous flowers; scapes not exceeding the leaves.......16. *V. renifolia.*

13*b*. Leaves not reniform.
Leaves ovate-cordate, with narrow sinus, usually less than 90°; basal lobes pubescent; apex rarely acute; slender runners in

summer; scapes much exceeding the leaves; seeds 1.5 mm. long, acute at the base, minutely rugose; upper petals narrow and twisted..........................19. *V. blanda.*

Leaves lanceolate; scapes as tall as leaves 21. *V. lanceolata.*

10*b*. Corolla lilac or pale violet; leaves deeply cordate; basal lobes overlapping, minutely hairy; spur 6 mm. long.................................15. *V. selkirkii.*

** Violets with leafy stems 14

14*a*. Style enlarged at the summit; spur short (2–4 mm.) or none 15

15*a*. Stipules nearly entire, soon scarious 16

16*a*. Petals yellow 17

17*a*. Root leaves usually 3, blades ovate-reniform, nearly glabrous, stem leaves broadly ovate, nearly glabrous; petals longer than the sepals; no spur......................23. *V. eriocarpa.*

17*b*. Root leaves usually one, sometimes more, long petioled or wanting; stem leaves broadly ovate-reniform, softly pubescent; stipules large, ovate-lanceolate; spur short ....24. *V. pubescens.*

16*b*. Petals not yellow; inner surface of petals white with yellow base, outside usually violet 25. *V. canadensis.*

15*b*. Stipules laciniate at the base, large and leaf-like 18

18*a*. Upper leaves and middle lobe of stipules entire or nearly so........................32. *V. rafinesquii.*

18*b*. Upper leaves and middle lobe of stipules plainly crenate.

Petals large, 2–3 times as long as sepals...34. *V. tricolor.*
Petals yellow, usually shorter than sepals.33. *V. arvensis.*

14*b*. Style not enlarged at the tip; spur long (4–12 mm.); stipules bristle-toothed 19

19*a*. Spur 4–8 mm. long; lateral petals bearded; style bent at the tip, slightly pubescent 20

20*a*. Petals white or cream-colored..............26. *V. striata.*

20*b*. Petals violet 21

21*a*. Leaves orbicular, cordate, crenate-serrate. Stipules ovate-lanceolate, serrately-ciliate toward the base...............27. *V. conspersa.*

Stipules linear, attenuate, entire except at the base.................28. *V. labradorica.*

21*b*. Leaves ovate, crenate or crenulate, obtuse, subcordate.

Leaves pubescent; stipules linear-lanceolate, with incised bristly teeth....... 30. *V. subvestita.*

Leaves glabrous; stipules linear, attenuate, sparsely spinulose-serrate..........29. *V. adunca.*

19*b*. Spur 8–12 mm. long; lateral petals beardless; style straight and smooth........................31. *V. rostrata.*

1. VIOLA PEDATA L. Bird's-foot Violet.

V. pedata var. *bicolor* Pursh.

Dry fields and open woods, April–September. General in southern part of Lower Peninsula.

Specimens examined.—Kalamazoo Co. (R. M. Gibbs & G. B. Sudworth, 1877); Cass Co. (C. F. Wheeler, 1890); Jackson Co. (S. H. & D. R. Camp 1893); Kent Co. (L. J. Cole, 1897); Calhoun Co. (W. J. Beal, 1898); Muskegon Co. (C. F. Wheeler, 1900); Montcalm Co. (B. Barlow, Sept. 1900); Van Buren Co. (H. S. Pepoon, 1905, No. 475); St. Clair Co. (C. K. Dodge, 1908); Oakland Co. (B. F. Chandler, Sept. 1914).

A specimen agreeing with *Viola pedata* var. *inornata* Greene was collected in Van Buren Co. (H. S. Pepoon, 1905, No. 474).*

2. VIOLA PALMATA L.

Wooded hills and dry soil. April–June. Mostly reported from the southeastern part of the Lower Peninsula. Wooded hills and dry, rich soil. April–June.

Specimens examined.—Ingham Co. (C. F. Wheeler, 1899); St. Clair Co. (C. K. Dodge, 1907); Oakland Co. (C. Billington, 1916).

3. VIOLA PAPILIONACEA Pursh. Hooded Blue Violet.

V. pratincola Greene.

V. domestica Bicknell.

Moist fields and beech-maple woods, May–August. Southern part of Lower Peninsula and one county of Upper Peninsula.

Specimens examined. — Hillsdale Co. (D. A. Pelton, 1885);* Gratiot Co. (C. A. Davis, 1890); * Ingham Co. (C. F. Wheeler, 1899); * Van Buren Co. (H. S. Pepoon, 1906); * Houghton Co. (C. K. Dodge, 1917).†

Late summer appearance. — Leaves dark green, smooth and shiny, rounded to cordate; cleistogamous capsules erect, reddish-purple, spotted with green; seeds yellow.

4. VIOLA SORORIA Willd. (Plate XXXV.) Common Blue Violet.

Moist meadows, shady ledges and dooryards. May–August. General in southern half of Lower Peninsula.

Specimens examined. — Keweenaw Co. (O. A. Farwell, 1883); * Kent Co. (A. A. Crozier, 1886); * Gratiot Co. (C. A. Davis, 1893); * Ingham Co. (L. J. Cole, 1895); * St. Clair Co. (C. K. Dodge, 1899); * Alger Co. (C. F. Wheeler, 1900); * Macomb Co. (W. S. Cooper, 1902); Cass Co. (H. S. Pepoon, 1903, No. 244); * Wayne Co. (C. K. Dodge, 1913) "abundant;" Oakland Co. (B. F. Chandler, 1916).

5. VIOLA SORORIA X TRILOBA Brainerd. (Plate XXXVI.)

According to Brainerd, this hybrid is probably identical with Prof. Greene's *Viola populifolia*. (See *Bull. Torr. Bot. Club*, 39: 92–93, 1912.) See *Pitt.*, 3: 337. 1898.

Specimens examined. — Ingham Co. (B. E. Thompson, 1919); Calhoun Co. (C. C. McDermid, 1921). The specimens collected in Ingham Co. were indentified by Dr. Brainerd.

6. VIOLA HIRSUTULA Brainerd.

V. villosa Nutt. (not Walt.).

Rich, dry soil and copses. April–May. Baraga County, in the Upper Peninsula.

The only specimen seen was collected and identified by H. T. Darlington in 1920. For a description of this species see an article by Dr. E. Brainerd, *Rhodora*, 9: 98. 1907.

7. VIOLA SEPTENTRIONALIS Greene.

Moist open woodlands.

This species was found by C. K. Dodge in rich, partially

shaded ground near Huron Mountain Club, Marquette County, in 1917.

8. Viola novae-angliae House.

Gravelly or sandy shores, or in crevices of rocks, along lakes and rivers. June.

The only specimen examined was collected by Miss Pauline Alford at Ironwood, in Gogebic Co., 1920. Identified by H. T. Darlington.

9. Viola affinis LeConte.

V. venustula Greene.

This species was segregated by Dr. Greene under the name of *Viola venustula*, allied to *Viola affinis* LeConte. (See *Pitt.*, 3: 333), but is considered by Dr. Brainerd to be a synonym for *Viola affinis*.

Moist meadows, low woods and shady borders of streams. April–May. One county in the Upper Peninsula and one in southeastern Michigan.

Specimens examined. — St. Clair Co. (C. K. Dodge, 1909); ‡ Schoolcraft Co. (W. T. S. Carvell, 1916), † "plentiful."

Sepals 6–7 mm. long, narrow, acute, distinctly 3-nerved; leaves with narrow sinus.

10. Viola nephrophylla Greene. Small Mottled Blue Violet.

V. vagula Greene.

Cool, mossy bogs and borders of streams and lakes. Infrequent, scattered.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs and G. B. Sudworth, 1887); * Huron Co. (C. K. Dodge, 1909); ‡ Mackinac Co. (C. K. Dodge, 1913), ‡ "common;" Gogebic Co. (H. T. Darlington, 1919).

11. Viola cucullata Ait. Marsh Blue Violet.

Wet, marshy places. Southern part of Lower Peninsula and a few places in the Upper Peninsula.

Specimens examined. — St. Clair Co. (C. K. Dodge, 1892), fide H. T. D. "abundant;" Belle Isle (O. A. Farwell, 1894); Van Buren Co. (H. S. Pepoon, 1906, 750); Chippewa Co.

(C. K. Dodge, 1914),‡ "abundant;" Schoolcraft Co. (C. K. Dodge, 1915);† Gogebic Co. (H. T. Darlington, 1919).

A variety of this species is distinguished thus: leaves more or less hirtellous, and the margin of the sepals "often interruptedly serrulate-ciliolate." Such a form was found by Wheeler and Longyear in Livingston Co. The specimen was checked by Dr. Brainerd, who calls it *forma prionosepala*. See *Rhodora*, 15: 112. 1913.

For a discussion of the *cucullata* group, see *Rhodora*, 6: 8. 1904. Some forms show white petals with a blue throat. In the typical form of this group, the beard of the lateral petals is strongly clavate; spurred petal glabrous; sinus of matured leaves wider than in *Viola septentrionalis*.

12. VIOLA FIMBRIATULA Smith. Ovate-leaved Violet.

V. ovata Nutt.

V. sagittata var. *ovata* T. & G.

Dry sandy fields and hillsides. May–August. Southern half of the Lower Peninsula.

Specimens examined. — Washtenaw Co. (C. F. Wheeler, 1885); Muskegon Co. (C. D. McLouth, 1890); * St. Clair Co. (C. K. Dodge, 1892) "dry, sandy ground, abundant;" Kent Co. (L. J. Cole, 1895); Bay Co. (G. W. Bradford, 1899); Muskegon Co. and Arenac Co. (C. F. Wheeler, 1900); Eaton Co. and Ingham Co. (C. F. Wheeler, 1901); Van Buren Co. (H. S. Pepoon, 1904).

13. VIOLA SAGITTATA Ait. Arrow-leaved Violet.

Moist banks and wet meadows. April–June. Southern half of the Lower Peninsula.

Specimens examined. — Macomb Co. (D. Cooley, 1844); Jackson Co. (H. S. and D. R. Camp, 1893); Hillsdale Co. (Wm. T. Wallace, 1899); Muskegon Co. (C. F. Wheeler, 1900); St. Clair Co. (C. K. Dodge, 1905); Huron Co. (C. K. Dodge, 1910) "plentiful."

A pubescent form, recognized by Dr. Brainerd as *Viola subsagittata* Greene, was found by C. F. Wheeler in Eaton Co. in 1901. See *Bull. Torr. Bot. Club*, 38: 4. 1900.

14. VIOLA EMARGINATA LeConte.

Dry woods and hillsides, September. Western side of Lower Peninsula.

Specimens examined. — Muskegon Co. (C. D. McLouth, 1898).*

15. VIOLA SELKIRKII Pursh. Great-spurred Violet.

Shady ravines, cold mountain forests, April-May. Scattered in the Upper Peninsula.

Specimens examined. — Alger Co. (C. F. Wheeler, 1900); Marquette Co. (B. Barlow, 1901, and C. K. Dodge, 1916) † "plentiful;" Schoolcraft Co. (W. T. S. Carvell, 1916).

Late summer appearance. — Leaves thick, dark green, pubescent, orbicular to ovate. Cleistogamous capsules round, pink to light purple. Seeds yellow.

16. VIOLA RENIFOLIA Gray. Kidney-leaved Violet.

V. blanda var. *renifolia* Gray.

Cold woods and arbor vitae swamps, May–August. Distribution general throughout.

Specimens examined. — Crawford Co. (G. H. Hicks, 1888); Cheboygan Co. (C. F. Wheeler, 1890) ;* Isabella Co. (C. A. Davis, 1892); † Ontonagon Co. (Mrs. W. S. Paul, 1895); † Alpena Co. (C. F. Wheeler, 1895); Marquette Co. (B. Barlow in 1901 and C. K. Dodge 1917) "abundant;" Chippewa Co. (C. K. Dodge, 1914) ‡ "abundant;" Gogebic Co. (H. T. Darlington, 1919).

Viola renifolia var. *brainerdi* Fernald is distinguished from the foregoing species by having summer leaves rounded at the apex; sinus narrow 1/3 to 1/4 length of leaves: runners rare. See *Rhodora,* 14:86. 1912.

17. VIOLA INCOGNITA Brainerd. Larger White Violet.

Low, wet, rich woods. April-May. Distribution general.

Specimens examined. — Gratiot Co. (C. A. Davis, 1890) "wet woods;" Isabella Co. (C. A. Davis, 1892); St. Clair Co. (C. K. Dodge, 1892) † "abundant;" Van Buren Co. (H. S. Pepoon, 1903); * Cheboygan Co. (F. C. Gates, 1911).

In *Viola incognita*, the sinus is quite open and larger than

Viola renifolia; leaves more or less acute at apex. Seeds obtuse at base, smooth, 2 mm. long.

18. VIOLA INCOGNITA var. FORBESII Brainerd.

Specimens examined.— Ingham Co. (B. E. Thompson, 1919).*

For a description of this form, see *Bull. Torr. Bot. Club*, 38: 7–8. 1911.

19. VIOLA BLANDA Willd. Sweet White Violet.

V. amoena LeConte.

V. blanda var. *palustriformis* A. Gray.

Cold ravines and moist shady beech-maple slopes in humus. April–June. Frequent in Upper Peninsula and in the southern, central, and northeastern part of the Lower Peninsula.

Specimens examined. — Macomb Co. (D. Cooley, 1846); * Iosco Co. (W. J. Beal and C. F. Wheeler, 1888); * Cass Co. (C. F. Wheeler, 1890); * Gratiot Co. (C. A. Davis, 1891); * Ingham Co. (C. F. Wheeler, 1893); * Calhoun Co. (W. J. Beal, 1898); * Alger Co. (C. F. Wheeler, 1900) * "very common;" Menominee Co. (C. A. Davis, 1905); Schoolcraft Co. (W. T. S. Carvell, 1916); † Gogebic Co. and Baraga Co. (H. T. Darlington, 1920).

This species is closely allied to *Viola pallens*. *Viola blanda* has upper petals narrow, reflexed, and often twisted, lateral petals beardless. *Viola pallens* has broadly obovate petals and lateral petals sometimes smooth and sometimes with a tuft of hairs. In *Viola blanda* the lower lobes of the leaves are pubescent; they are smooth in *Viola pallens*. There is no rootstock, but it has runners; seeds 1.5 mm. long, dark brown; does not grow in as wet places as *Viola pallens*. See *Rhodora*, 7: 1 and 245. 1905.

20. VIOLA PALLENS (Banks) Brainerd.

V. blanda, recent authors.

V. rotundifolia var. *pallens* Banks.

Springy lands and along cold brooks. April–June.* Frequent in Upper Peninsula and the southern half of the Lower Peninsula.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs and G. B. Sudworth, 1877); Gratiot Co. (C. A. Davis, 1888);

Alcona Co. (D. A. Pelton, 1888) fide H. T. D.; Ingham Co. (Wheeler and Longyear, 1898); Marion Is., Grand Traverse Bay, (C. F. Wheeler, 1898); Beaver Is. (C. F. Wheeler, 1900); Marquette Co. (B. Barlow, 1901, and C. K. Dodge, 1917) † "abundant;" Van Buren Co. (H. S. Pepoon, 1903); St. Clair Co. (C. K. Dodge, 1909) ‡ "plentiful;" Chippewa Co. (C. K. Dodge, 1914) ‡ "abundant;" Alger Co. (C. K. Dodge, 1916) † "plentiful;" Gogebic Co. (H. T. Darlington, 1919).

Late summer appearance. — Leaves pale green, smooth, orbicular to ovate; cleistogamous capsules procumbent, green when young, then purplish-brown and green, small. Some petals show a tuft of hairs and some are smooth. Seeds are almost black and much smaller than those of *Viola blanda*. Has an erect rootstock and runners, grows in wet soil near springs or brooks. See *Rhodora*, 7: 1 and 245, Dec. 1905.

21. Viola lanceolata L. Lance-leaved or Water Violet.

Open bogs and moist meadows, May–August. Distribution general, mostly in southeastern part of the Lower Peninsula.

Specimens examined. — Van Buren Co. (R. M. Gibbs, 1875); Alcona Co. (W. J. Beal, 1888); Kent Co. (L. J. Cole, 1895); Muskegon Co. (C. F. Wheeler, 1900); Montcalm Co. (B. Barlow, 1900); Cass Co. (H. S. Pepoon, 1904, No. 61); St. Clair Co. (C. K. Dodge, 1909) "abundant;" Iosco Co. (C. K. Dodge, 1912); Chippewa Co. (C. K. Dodge, 1914) "abundant;" Schoolcraft Co. (C. K. Dodge, 1915) † "abundant;" Berrien Co. (H. T. Darlington, 1917).

22. Viola rotundifolia Michx.

Cold woods, April–May. From one county in the Upper Peninsula.

Specimen examined. — Dickinson Co. (C. F. Wheeler, 1892) "very rare."

23. Viola eriocarpa Schwein. Smooth Yellow Violet.

V. scabriuscula Schwein.

V. pubescens var. *scabriuscula* T. & G.

Low, wet, shady woods, May–August. Common in southern half of Lower Peninsula and scattered in Upper Peninsula.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs, 1874); Keweenaw Co. (O. A. Farwell, 1886); Shiawassee Co. (G. A. Hicks, 1889); Oakland Co. (W. A. Brotherton, 1894); St. Clair Co. (C. K. Dodge, 1899) "abundant;" Ingham Co. (C. F. Wheeler, 1900); Alger Co. (C. F. Wheeler, 1900); Marquette Co. (B. Barlow, 1901); Cass Co. (H. S. Pepoon, 1904, No. 193); Cheboygan Co. (F. C. Gates, 1911, No. 466); Gogebic Co. (H. T. Darlington, 1919).

Intergrades with *Viola pubescens.*

24. Viola pubescens Ait. Downy Yellow Violet.

Dry, rich woods. May–August. General in southern half of Lower Peninsula; a specimen examined from one county of Upper Peninsula.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs, 1877); Hillsdale Co. (D. A. Pelton, 1885); Ionia Co. (C. F. Wheeler, 1889); Gratiot Co. (C. A. Davis, 1890); Cass Co. (C. F. Wheeler, 1890; Ingham Co. (C. F. Wheeler, 1898); St. Clair Co. (C. K. Dodge, 1899) "abundant;" Gogebic Co. (H. T. Darlington, 1919).

25. Viola canadensis L.

Shady woods or uplands, May–July. Distribution general.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs, 1874); Gratiot Co. (C. A. Davis, 1888); Shiawassee Co. (G. H. Hicks, 1889); Cass Co. (C. F. Wheeler, 1890); Ingham Co. (L. J. Cole, 1895); St. Clair Co. (C. K. Dodge, 1896); Muskegon Co. (C. D. McLouth, 1899); Alger Co. (C. F. Wheeler, 1900, No. 28); Marquette Co. (B. Barlow, 1907, No. 93); Van Buren Co. (H. S. Pepoon, 1906, No. 715); Charlevoix Co. (E. A. Bessey, 1912, No. 20); Bois Blanc Island (C. K. Dodge, 1914).

Still in flower in December 1920 in plot at Michigan Agricultural College.

26. Viola striata Ait.

Low, shady ground, April–October. Southern half of the Lower Peninsula.

Specimens examined. — Kalamazoo Co. (R. M. Gibbs and G. B. Sudworth, 1877); Ionia Co. (C. F. Wheeler, 1889);

Gratiot Co. (C. A. Davis, 1891); St. Clair Co. (C. K. Dodge, 1892); Wayne Co. (B. F. Chandler, 1915).

27. VIOLA CONSPERSA Reichenb. American Dog Violet.

V. muhlenbergia Torr.

Low or shaded ground, April–May. Southern half of Lower Peninsula. A few specimens from the Upper Peninsula.

Specimens examined. — Kalamazoo Co. (Gibbs and Sudworth, 1877); * Gratiot Co. (C. A. Davis, 1888); * St. Clair Co. (C. K. Dodge, 1892) * "abundant;" Ingham Co. (L. J. Cole, 1895); * Crawford Co. (C. F. Wheeler, 1898); * Alger Co. (C. F. Wheeler, 1900) * "common;" Cass Co. (H. S. Pepoon, 1903); * Marquette Co. (C. K. Dodge, 1916) † "abundant;" Muskegon Co. (C. D. McLouth).*

Late summer appearance. — Leaves light green, smooth, ovate, with scattered hairs.

28. VIOLA LABRADORICA Schrank.

V. muhlenbergiana var. *minor* Hook.

Cold Alpine situations. August.

The only specimen seen was collected by H. T. Darlington, 1919, on a wooded hill in Gogebic County. Indentified by H. T. D.

29. VIOLA ADUNCA Smith. Hooked Violet.

V. canina L. var. *adunca* Gray, 1872.

Mountainous and hilly regions. May–July. In the northern part of the Lower Peninsula and in the Upper Peninsula. Infrequent.

Specimens examined. — Keweenaw Co. (O. A. Farwell, 1887); * Marquette Co. (C. F. Wheeler, 1896); * Beaver Island (C. F. Wheeler, 1900); * Cheboygan Co. (F. C. Gates, 1911, No. 396).*

Subglabrous forms of this species are found in the state.

30. VIOLA SUBVESTITA Greene.

V. canina var. *puberula* S. Wats.

V. arenaria Gray (not D. C.)

Shady, sterile soil. May–August. Central part of the Lower Peninsula and at a few points in the Upper Peninsula.

Specimens examined. — Keweenaw Co. (O. A. Farwell, 1887); Oscoda Co. (D. A. Pelton, 1888); Isabella Co. (C. A. Davis, 1896); Crawford Co. (C. F. Wheeler, 1898); Muskegon Co. (C. F. Wheeler, 1900); Menominee Co. (C. A. Davis, 1905, No. 219) "sandy barrens, common;" St. Clair Co. (C. K. Dodge, 1906), sand-dunes; Gogebic Co. (H. T. Darlington, 1919).

31. Viola rostrata Pursh. Long-spurred Violet.

Shady hillsides and open woods. April–July. General in southern half of the Lower Peninsula.

32. Viola rafinesquii Greene.

Specimens examined. — Macomb Co. (Dr. D. Cooley, 1844); Gratiot Co. (C. A. Davis, 1888); Shiawassee Co. (G. H. Hicks, 1889); St. Clair Co. (C. K. Dodge, 1892) "plentiful;" Kent Co. (L. J. Cole, 1895); Cass Co. (H. S. Pepoon, 1903); Ingham Co. (W. J. Beal, 1905); Oakland Co. (B. F. Chandler, 1916).

33. Viola arvensis Murr. European Field Pansy.

Found around cities and cultivated land, April–October. One county in each of the extreme northern, southern, and western parts of the state.

Specimens examined. — Sanilac Co. (W. W. Weir, 1894) "plentiful;" St. Joseph Co. (G. D. Grossman, 1911); Marquette Co. (C. K. Dodge, 1916),† sandy soil, "occasional."

Found in flower growing as a weed, in Charlevoix Co., August 29, 1920, by H. T. Darlington.

34. Viola tricolor L. Common Pansy.

Escaping from cultivation and persisting around cities or villages. Southeastern part of Lower Peninsula, and in the Upper Peninsula.

Specimens examined. — Macomb Co. (Dr. D. Cooley, 1851); Keweenaw Co. (O. A. Farwell, 1888); St. Clair Co. (C. K. Dodge, 1888).

The species named below are some of those listed by Dr. Greene as sometimes occurring in Michigan and neighboring states.

V. CRASSULA Greene.

Closely allied to *V. cucullata*, but segregated by Dr. Greene. A genuine bog violet collected near Jackson, Michigan, in 1912. Not mentioned by any other author.

V. PERAMOENA Greene.

Closely allied to *V. cucullata*, but not a bog violet. Distinguished from it by dark green herbage, slender petioles and peduncles; short, broad, obtuse sepals, breadth and depth of color of petals.

V. RAFINESQUII Greene.

Considered by Dr. Brainerd as a synonym for *V. tenella* Muhl. Included in this list as a valid species.

V. PRATINCOLA Greene.

Synonym for *V. papilionacea* Pursh. See *Pitt.*, 4: 64. 1899.

OREGON AGRICULTURAL COLLEGE
CORVALLIS, OREGON

PLATE XXXV

Viola sororia Willd.

PLATE XXXVI

VIOLA SORORIA X TRILOBA BRAINERD

THE GENUS CUSCUTA IN MICHIGAN

T. G. YUNCKER

Michigan is located at about the northernmost limits of the range for the genus *Cuscuta* in North America. A few specimens from Canada have been seen, but, with one or two exceptions, none of the species grows luxuriantly there. Southward the genus extends through the Isthmus of Panama and the West Indies into South America as far south as central Chile and Argentina. In Michigan no specimens have been seen farther north than Oceana County, although it is to be expected that *C. Gronovii*, *C. Cephalanthi*, *C. pentagona* and *C. Epithymum* may be found anywhere in the State.

There are fifty-four species of *Cuscuta* known to occur in North America, eight of which have been found in Michigan. Of these eight, two are European and six are natives of North America. Of the six native species, one, *C. indecora*, is possibly a temporary introduction from its more natural habitat west of the Mississippi River. The two European species are both parasitic on cultivated plants, *C. Epithymum* occurring commonly on clover and other legumes and *C. Epilinum* on flax. Neither of these two species is very common in North America, as only scattering specimens have been reported. Of the native species, only two are known to be harmful to cultivated crops, *C. pentagona*, which occurs frequently on clover and alfalfa, and *C. indecora*, which is found occasionally on clover and alfalfa.

KEY TO THE SPECIES

I. Stigmas linear; capsules definitely circumscissile in a regular line near the base. (Introduced European species.)
   Styles, including the stigmas, exceeding the length of the ovary; calyx lobes scarcely overlapping; usually occurring on leguminous hosts ....1. *Cuscuta Epithymum*.

Styles, including the stigmas, not exceeding the length of the ovary; calyx lobes overlapping; always occurring, so far as observed, on *Linum* ...... 2. *Cuscuta Epilinum.*

II. Stigmas capitate; capsules not circumscissile. (Native species.)

Flowers sessile, surrounded by many bracts, closely compacted into a tightly wound, rope-like cluster about the host .... 3. *Cuscuta glomerata.*

Flowers sessile or pedicellate, without bracts, inflorescence not rope-like in habit.

Flowers somewhat fleshy; cells of flowers papillate.

Flowers 5-merous, comparatively large; scales well developed .... 4. *Cuscuta indecora.*

Flowers as often 4-merous as 5-merous, smaller, scales usually represented only by wings or projections along the stamen attachment to the corolla .... 5. *Cuscuta Coryli.*

Flowers not fleshy, smooth.

Corolla lobes acute, usually with inflexed tips; flowers sessile or sub-sessile .... 6. *Cuscuta pentagona.*

Corolla lobes obtuse, tips never inflexed, inflorescence looser.

Flowers 5-merous; corolla ordinarily remaining at the base or about (not capping) the pointed capsule .... 7. *Cuscuta Gronovii.*

Flowers 3-4-5-merous; corolla capping the globose capsule .... 8. *Cuscuta Cephalanthi.*

CUSCUTA (TOURN.) L.[1]

1. CUSCUTA EPITHYMUM Murr. Clover dodder.
Cuscuta trifolii Bab.

This species, which has been introduced from Europe, is found occasionally on clover in the State. It is often confused in the herbaria with *C. pentagona* but it is easily distinguished by its filiform stigmas and circumscissile capsules. This species is apt to be spread from one locality to another by means of

[1] For a complete synonymy, description, and pictures of the different species listed herein, the reader is referred to the following paper: T. G. Yuncker, *Revision of the North American and West Indian Species of Cuscuta, Illinois Biological Monographs*, 6 : 93–141. 1920.

contaminated clover or alfalfa seed. When once established it may do considerable damage to the crop.

Specimens examined. — St. Clair Co. (C. K. Dodge in 1910); Oceana Co. (Wear); Macomb Co. (Ward).

2. CUSCUTA EPILINUM Weihe. Flax dodder.

This species, also introduced from Europe, is rare in North America where it always, so far as known to the writer, occurs on Linum. It may do considerable damage when once established.

Specimens examined. — Ingham Co. (C. F. Wheeler in 1899).

3. CUSCUTA GLOMERATA Choisy. Glomerate dodder.

Cuscuta paradoxa Raf.

This species is occasionally found in the southwestern corner of the State. It is typically a prairie species. It seems to prefer tall Compositae as Helianthus, Solidago, etc. This is one of the most easily identified of the dodders. The characteristic, continuous, rope-like clusters of flowers which are wound tightly about the host give this plant an appearance that is not easily forgotten after having once been seen.

Specimens examined. — Berrien Co. (H. S. Pepoon, No. 936); Cass Co. (H. S. Pepoon, No. 300).

4. CUSCUTA INDECORA Choisy. Pretty dodder.

Cuscuta decora Engelm.

The species name, *C. indecora*, given by Choisy to a very poor specimen, is really inappropriate because this is one of our prettiest dodders and was recognized as such by Engelmann when he changed the name to *decora*. This species, common throughout the prairie states west of the Mississippi River, is rare in Michigan. Occasional specimens have been found in western Illinois. It attacks various low herbs and shrubs but chiefly Leguminosae and Compositae. The specimen here recorded was on Ambrosia sp. It is thought that the single specimen seen in this State may have been an accidental introduction with seed from some western state.

Specimens examined. — Oceana Co. (Miss S. E. Wagner in 1919).

5. CUSCUTA CORYLI Engelm. Hazel dodder.
Cuscuta inflexa Engelm.

This species is frequently confused with *C. indecora* from which it markedly differs particularly in the possession of commonly 4-merous flowers and rudimentary scales. It seems to prefer shrubby hosts like the hazel.

Specimens examined. — St. Clair Co. (C. K. Dodge, Nos. 104 and 372 and unnumbered collections in 1894 and 1896; O. A. Farwell, No. 5692); Cass Co. (H. S. Pepoon, No. 190, this number is also applied to sheets of *C. Gronovii*).

6. CUSCUTA PENTAGONA Engelm. Field dodder. Clover dodder.
Cuscuta arvensis Beyr.

This species is probably more frequent than the list of specimens examined would indicate. It attacks low herbs, frequently clover and alfalfa, doing considerable damage to these crops when it is allowed to obtain a foothold.

Specimens examined. — Van Buren Co. (H. S. Pepoon, No. 764); Ingham Co. (T. G. Yuncker in 1917; Breisch in 1921).

7. CUSCUTA GRONOVII Willd. Gronovius's dodder.

This is our most common dodder. It is very abundant in low, wet places on various herbs and shrubs, more frequently on Impatiens, Salix, Saururus, Cephalanthus, etc.

Specimens examined. — Washtenaw Co. (Miss Almendinger); Oakland Co. (C. Billington in 1920; O. A. Farwell, Nos. 1291a, 4415, 4582a, 4685; Brotherton in 1898); Van Buren Co. (A. W. DeSelm, No. 8; H. S. Pepoon, Nos. 837 and 892); Macomb Co. (O. A. Farwell, No. 4632; Dr. D. Cooley in 1882); St. Clair Co. (C. K. Dodge in 1892 and 1896); Genesee Co. (D. Clark, No. 4264); Cass Co. (H. S. Pepoon, Nos. 190 [this number also applied to a collection of C. Coryli], 191, 450); Montcalm Co. (Barlow in 1900); Gratiot Co. (C. A. Davis in 1889 and 1892); Berrien Co. (O. E. Lansing, No. 3301; Hill, No. 175—1894); Clinton Co. (T. G. Yuncker, No. 742); Ionia Co. (T. G. Yuncker, No. 695); Ingham Co. (T. G. Yuncker in 1917; Herb. Mich. Agr. Coll. in 1885); Jackson Co. (S. H. & D. R. Camp in 1897); Lenawee Co. (C. Billington in 1914); Sugar

Loaf Lake (Burgess, No. 476); Prairie Rhonde (Burgess, No. 316); Rollin (W. J. Beal).

8. Cuscuta Cephalanthi Engelm. Button-bush dodder.
Cuscuta tenuiflora Engelm.

Next to *C. Gronovii*, this is the most common dodder in Michigan. Its range coincides very closely with that species also. One is apt to confuse these two species, although this should not occur if one remembers that this species does not possess pointed capsules and that it has its floral parts commonly in 3's and 4's as well as 5's. It is most abundant on shrubs and tall herbs, being frequently found on Cephalanthus, Salix, Solidago, etc.

Specimens examined. — St. Clair Co. (C. K. Dodge in 1896; Cooper in 1901); Oakland Co. (W. S. Cooper in 1901; O. A. Farwell, No. 5589a); Wayne Co. (O. A. Farwell, Nos. 4407, 1945, 5124, 1291; C. Billington in 1918; Suttie in 1892); Jackson Co. (S. H. & D. R. Camp in 1893).

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THE FUNCTION OF THE PERSONNEL DEPARTMENT

C. C. EDMONDS

The growth and development of large-scale industry have served to emphasize the necessity for careful consideration of the human factor. In small-scale industry, where close personal contact between the management and the workers was possible, the opportunities for misunderstanding and misconstruing acts and intentions were very much fewer than under present conditions. The growth of absentee ownership and the increasing tendency for the ownership of the tools of production to be separated from the worker have likewise brought about some very difficult problems.

Laws have been passed almost from the beginning of the present factory system to better the conditions of the worker and to coördinate the desires and aims of the employer and employee. A great deal of good has resulted from many of these laws for both parties; but the question is in many respects a personal one — one that concerns the individual employer and his employees in so direct a manner as to require some solution other than mere additional legislation.

The recognition of the fact that labor turnover involves a tremendous expense to both the employer and the worker was an important factor in arousing industry to an effort to secure some solution of the problem. A labor turnover of 200 per cent had often been regarded as a necessary evil, but the interpretation of this percentage into loss in terms of dollars and cents produced a very different effect, and interest became centered in efforts to reduce this element of waste.

The development of a separate function in management, which has to do with human relations, has been the answer proposed to this question. Before the outbreak of the recent war,

some progress had been made in studying the problem and in applying various solutions; with the entrance of the United States into the war, the movement advanced very rapidly. War, with its demands on the man-power of the nation, also required that industry greatly increase production, even though hampered by a lack of workers, both skilled and unskilled. The importance of the worker as a producing unit was recognized as never before, and efforts were directed toward the development of men capable of organizing and carrying on the work of the personnel department in industrial organization.

The original personnel departments were in truth but employment departments and concerned themselves, not with the problem of personnel relations as a whole, but simply with two points in the worker's industrial life, when he was hired, and when he was "fired," or left the employment of the company. Between these two periods, the employment department was not concerned as to the worker's conditions or ability, and in so limiting itself, it differed from the personnel department as we now know it. It should be recognized, however, that although better than the old method of hiring and "firing" through the foreman, many of our present personnel departments are but employment offices of this narrow type.

With the broader development of the personnel department, new functions have been added to that of employment, so that we now find a wide range of activities embraced, such as education of the worker, safety and health, industrial research, and, in many cases, group relations. In some instances, functions have been added to the personnel department which are not within its province, largely for lack of a better place to put them, but such miscellaneous additions should be carefully avoided as tending to confuse the true purpose of the department and in no way adding to its usefulness. Besides the foregoing activities of the department, a great deal of time and energy is expended in devising methods of attracting suitable applicants to the industry, and in inducting them into the service of the company. The personnel department has at the present time an unexcelled opportunity for service in this field.

During the war and for the two-year period following, industry found it necessary, in order to keep up the production demanded, not only to utilize almost any kind and type of labor available, but also to search diligently for additional workers to keep up the rapidly changing working force. Such a condition meant, of course, that the element of selection was almost entirely absent, and that many workers who were entirely unqualified, either through lack of training or of initial intelligence, were inducted into the industries.

The workers themselves were not long in understanding the situation, and often took the opportunity of entering new occupations, knowing that by "bluffing the job" in several factories, they could thereby acquire sufficient skill to hold a place in the new line of work. Many others shifted from occupation to occupation, at each place gaining a smattering of information at the employer's expense through lowered production, defective work, and additional supervision required.

With the coming of the present business situation, most industries found it necessary to reduce greatly their working forces, so that most of the makeshifts and misfits have been at least temporarily eliminated from the pay-roll. With the resumption of industry, however, after the present lull, the personnel department will again find itself in the position of needing additional workers for the many tasks in and about the factory. Will it then be a case of hiring the first to apply, or will some intelligent basis for selection be available for use?

The psychologists, by their work during the war, have shown that it is both possible and practical, not only to develop tests by which to determine the relative intelligence or mental ability of a person, but also to determine the degree of skill or expertness attained in a particular trade or occupation. In the vast numbers of men who were picked up by the draft, there were men of all walks of life and of all occupations.

The question was how to find the man with certain trade qualifications or skill. Reliance upon the person's own statement as to his skill or ability was found, in the majority of cases, to be unsatisfactory and unreliable, so trade tests were

devised to determine exactly a recruit's familiarity with and knowledge of a certain trade or occupation. Enough tests were developed and used to prove that this method could be successfully used to determine quickly and accurately a man's special skill or training.

Industry, with but few exceptions, has been slow in adopting or even investigating such methods of selecting men, preferring to go on in the old way of selecting by guess, or by the instinct of the interviewer. In most cases, reliance is placed upon the statement of experience given by the applicant, and upon his evident familiarity with technical or trade terms, as shown in the course of the interview. Usually a man is hired for a certain task, and after a time, if he has not proved satisfactory, another worker replaces him. This process of elimination is repeated until eventually a more or less satisfactory worker is secured, although at a very high cost.

The personnel department could use this period of readjustment to develop tests for many of the more important tasks about the factory so that later, in selecting the working force, a group of competent trained workers could be secured.

Not only would the use of such tests be beneficial to the employer through the eliminating of the amateur and the makeshift worker from the ranks of the skilled, but the skilled workers also would be benefited, since ability could be recognized and rewarded, not penalized, as is often the case now because of the shortcomings of the many inefficient workers in a class.

The trade test would be fair and just to the unskilled workers also, because it would in no way bar them from advancement as soon as they qualified for it, but would simply refuse to recognize and pay them as skilled workmen while still inefficient.

Another very important function of the personnel department, which has for the most part been entirely overlooked, is the careful and scientific analysis of the various tasks in order to determine exactly the nature and content of each task. Further problems are to determine, so far as possible, the type of worker best adapted for the task, the amount of work a man

can and should do in a day without physical or mental injury, and the wage that should be attached to the task in order to compensate adequately the worker for his efforts.

Scientific management has proved conclusively that tasks can be classified and analyzed into their component parts, but in only a few industries has this knowledge been put to any appreciable use.

The personnel department, working in conjunction with other departments, would find here a very fertile field for development, and one that, coupled with a carefully planned series of trade tests, would be of great value in the work of selection and placement. At the present time, with the many indefinite and conflicting terms used to describe each task, it is difficult indeed, not only for the personnel department to determine accurately what a man's capacity and experience are, but for the worker to form any definite idea of the task he is securing, except by the expensive trial and error method.

In large industries, it would undoubtedly be impossible at the present time, to classify and analyze all the various tasks, but a study of the more important ones would certainly be of advantage with the resumption of production.

A further function of the personnel department arises in connection with wage disputes. Many industries are at the present time under the necessity of cutting their cost of production to meet a lower market. In doing this, they find that their labor costs also must be decreased. The difficulty of inaugurating a wage decrease is evident, as labor is anxious to hold what has been secured in the way of increased wages during the period of the war, and believes also that any proposed cut is an unjustified attempt to lower standards of living, and should, therefore, be fought at every possible turn.

It is, of course, possible for the management of an industry to announce simply an arbitrary wage reduction with the ultimatum that it is necessary under the new conditions, and therefore must stand. This policy, however, is one that does not secure the coöperation of the workers, and in many cases may prove less effective in cutting costs than was expected. The

personnel department which has been functioning properly, and has thus established itself in the eyes of both the management and the men, can be of great service in this period of wage re-adjustments.

If the personnel director chooses to be merely a figure-head, he can sit idly by while the labor policy of the company is being revised as regards such important features as hours, wages, or working conditions, but if he is to fulfill the true obligations of his position, he must have a voice in this policy-making, and, having this voice, must use his influence and guidance to the end that justice for both sides may be secured.

A personnel department which at this critical time entirely loses its independence of thought and action, and becomes but a mechanical functionary for carrying out a labor policy externally made, cannot expect to have any standing in the eyes of the worker. It must accept its twofold responsibility as the representative of both the employer and the employees, and be the point at which they can meet and settle their problems in common. If this relationship is to be maintained, the department must function both properly and fairly at this most critical time.

In case a wage reduction is necessary, the personnel department should see to it that the reduction is made, not by simply taking advantage of an opportune time, but on the basis of justice both to the company and to the worker, with consideration of the difficulties of each before deciding the problem. A wage reduction which cannot be justified by the personnel department will nullify the latter's powers, and reduce it to a mere employment department with few extra functions. Any attempt to use the present situation to unfair advantage should, therefore, be combated by the personnel department as harmful not only to the worker, but to the company and department as well.

Any department, dealing with as vital a problem as human relations, must be an important department of an organization in order to function properly, and to protect and direct the interests of all as regards the personnel of the organization. A

personnel department without a voice in the matter of determination of policy is indeed ineffective. Therefore, in order that the department may properly carry out these most vital functions, it should rank equal in matters of common interest with the other major departments.

University of Michigan

A COURSE IN FOREIGN TRADE

C. E. GRIFFIN

The teaching of foreign trade cannot be considered apart from the other courses that have come into existence in the last few years in response to the demand for business education. These courses mark a decided change in the work of our departments of economics. The student of the past approached the work in economics in much the same way as he approached the work in history or political science. It was not demanded that these courses should prepare him for a specific vocation, or even for such a general field of work as business, nor was this the primary purpose of the teachers of economics.

On the contrary, the courses in economics, taken as a group, were held to constitute a social science in which the student would be trained to think logically, and to observe the principles of the scientific method in dealing with social and economic problems. The point of view was that of the scientist in his search for "truth for truth's sake." So far as instruction in economics departed from this purely scientific point of view, it adopted that of the citizen or statesman interested in the solution of problems involving the relation between the individual and society, and particularly the relation between the individual and society politically organized in a state. It was and is *political* economy or at any rate *social* economy.

The attitude of the leading advocates of the newer business courses I conceive to be somewhat different. The point of view is not purely that of the scientist, nor of the statesman, nor of the citizen. It is primarily the point of view of the business man in search of profits.

The scientist is interested in the single-eyed search for truth, regardless of the practical importance of this particular bit of truth upon any practical problem of the day. It would be un-

wise indeed to adopt the utilitarian point of view so completely as to deprecate work of this sort. Man finds himself in a small clearing in the midst of a jungle of ignorance. His task is to increase the size of the clearing, and it makes comparatively little difference whether he hews away the jungle in one direction or another, for we may well believe that the jungle is limitless and man's little clearing is pitiably small. But, to carry the metaphor just one step further, it may be profitable to devote some time to the instruction of the rising generation in the most efficient use of the land which is already cleared. That is the relation of the art of business administration to the science of economics.

The point of view, then, of the business courses is that of the business man. Of course, the business man is also a citizen and a member of society, and hence he is interested in those social and economic problems that confront society at large, but primarily he is the economic man in search of profits. It should also be noted that the purpose of a university course in business administration is to train men for positions which require some adaptability and the exercise of judgment upon business policies. The aim is not to train clerks or bookkeepers. That, important as it may be, is the province of the high school, business college, or continuation school.

The demand for courses of this kind has been so great that many schools have introduced dozens of courses of an extremely practical nature in the effort to catch the tide at the flood. One school undertakes to prepare a man for business by a four-year course, in which the freshman year is given over to one course in general economics, three hours a week for the first semester, a course in economic resources of the United States, and accounting and business law. The student's general education, outside the chosen field, is insured by a three-hour course in rhetoric.

Having laid this broad foundation, the student is then conducted through a number of highly specialized courses designed to fit him for the specific niche which he is to occupy in the world of business. This is not an exaggerated picture of

the work of a commercialized correspondence school, nor of a business college. It is the program of work announced by one of the large universities of the country. That this sort of education is popular is evidenced by the fact that this particular institution has over 125 teachers on the staff of its business administration department.

There are several valid criticisms of this type of education:

(1) Few students know at the time they leave the high school in just what branch of business they will find themselves four years later, and much less can they know whether they will wish to remain in that line. Thus even if it were possible for a university to fit a man to perform the work of a traffic clerk (and even this is not admitted), it must follow that there will be a large percentage of misfits.

(2) Such a plan does not recognize sufficiently the fact that the four years of college must train the individual for life in all its aspects — for his life as a consumer as well as a producer, for his life as a citizen as well as a traffic clerk. Courses in sociology, literature, history, and political science are displaced by practical courses in office systems and salesmanship.

(3) A further objection is that in comparatively few of the new courses has a sufficient body of knowledge been accumulated and a sufficient number of principles been deduced to make instruction in them worth while. Before a subject can properly find a place in a university curriculum, it should have a body of principles, generalizations, and theory which will, to some extent, tax the intellectual and logical powers of the student. To say this is not to endorse entirely the disciplinary theory of education, which holds that the subject matter studied is of no importance if the student gets a certain amount of mental gymnastics. On the other hand one need not accept the content theory, which in its crude form holds the mind to be like a vessel into which is poured a certain amount of information.

The ideal course should train the student to use his mind, preferably in a line of work allied in a general way, at least, to the realities of life which he will encounter outside the college walls. The course should not be a "fact" course. This does

not mean that facts and statistical data should not be presented, but that they should be presented as materials upon which his powers of observation and generalization can be exercised. They are the pieces with which the game is played.

There is a considerable diversity of opinion as to the proper scope and content of most of the business courses. This is especially marked in the teaching of foreign trade. On the one hand, we have those who follow the classical development of the theory of international commerce, which views international trade as a special problem in the theory of value. On the other hand, we have those courses described as "practical exporting."

The course in international commerce has the prestige of age and of the contributions of the great thinkers of political economy. It certainly meets the requirement of presenting to the student a mental task worthy of his best efforts. It will be recalled that John Stuart Mill considers it wise to give warning to his readers before entering upon the theory of international values that they are now approaching the most difficult subject of economic science.

Another argument in favor of this concept of the course is that it explains the basis for all trade and is essential to an understanding by the business man, as well as by all citizens, of the fundamental nature of trade, and of the problems arising out of the balance of trade. Nevertheless, it must be admitted that the student who desires at least an introduction to the problems he is likely to meet in selling goods in foreign markets, or buying goods from other countries, will not be very much enlightened on these points by reading Mill.

If this is unsatisfactory as a training course for business, the practical exporting course is still less desirable. A course of this type disregards, if it does not by implication contradict, the accepted theory of international values. This tendency in the ultra-practical courses is accentuated by the fact that some of the teachers and many of the text writers approach the subject from the side of business and have no conception of the place of foreign trade in a general economic system. They are

not primarily interested in such questions, but rather in the business problems of the individual exporter.

If they do turn to questions of national policy, we find them teaching such doctrines as the following, which is quoted from a recent book now being used by the classes of a large eastern university. "No matter what efforts our competitors may make, we can meet them and beat them if we will but protect our incomparable home market, while developing on sound principles those foreign markets which offer natural and permanent outlets for our surplus. The ideal foreign policy for America would at once give us the highest possible commercial independence and as far as possible make the rest of the world depend on us." [1]

Some of these subjects are of so little importance that they have no place in a university course. An example is the question of packing goods for export. Whether potatoes for export to Latin America should be sent in barrels or in crates would hardly seem to call for formal consideration of a university class. The objection to a course of this kind does not rise primarily from the fact that the subjects treated are inconsequential, for many of the subjects treated in this type of course are of considerable importance. For example, the question of commercial organization and of the channels through which goods pass on the way from producer to consumer, is a sufficiently broad question to be a matter of general business policy and even, if properly treated, to be a question of academic interest.

Shall our exports be carried on through a chain of independent middlemen, or shall the work of these middlemen be taken over by the manufacturer in this country, or by the buyer in the foreign country? Why are some goods sent through the channel of specialized middlemen and others through a highly integrated marketing system? How shall we explain the radically different export organization of the United States, England, Germany and Japan? Are any broad tendencies in the methods and organization of trade discernible? These

[1] Hammond and Jenks, *Great American Issues*, p. 196.

subjects would seem to be worthy of consideration. The objection to this phase of the work of the practical courses is that very little real study and constructive imagination have been applied to these questions. The result is that a mass of unrelated facts and description is given with no principles or generalization, either logical or historical.

Is there a possiblity of a course between these extremes? We shall attempt to outline one that will avoid the objections to the two types considered. It may possibly suggest a solution for some other business courses.

It seems wise in any subject in this business group to find that part of general economics with which it is most closely allied, and to spend some time in refreshing the memory of the student on this phase of his previous work, and in pointing out the bearing of these economic principles upon the problems in hand. If the subject be marketing, we can profitably spend some time on price as the regulator of supply and demand, upon the principle of specialization, and upon the fact that the work of middlemen is a manifestation of the principle of division of labor. If the subject be industrial organization and management, one might introduce the discussion with the principles of division of labor, the economic function and profits of the entrepreneur, and the historical development of the present industrial system.

In the case of foreign trade, the proper approach seems to be the theory of international values. A thorough exposition of the orthodox theory of international trade is followed by an application of this theory, first, to the history of our own balance of trade, and secondly, to the present balance of trade of the United States and other countries.

This approach gives a background for the remainder of the course. Here one can make an effort to dispel the mercantilist philosophy from the minds of his students. That the teacher will be entirely successful in accomplishing this end in the few weeks at his disposal is quite unlikely. But whether he is entirely successful or not, it is worth while to bind practical foreign trade problems to the economic explanation of the whole

system. That the practical business of foreign trade should actually fit into the general scheme of theoretical economics seems to surprise many students.

Besides providing an opportunity for a more or less convincing demonstration of the operation of economic principles, this approach enables the student to see the place of the individual purchases and sales, and the function of the individual traders in relation to international trade in general. Lastly, it has the very practical result of impressing upon the student that he is not entering upon an entirely new field in which his general economics should speedily be discarded. After the first few weeks of the course, one will rarely hear the expression, "Theoretically this is true, but practically it is quite otherwise."

After this part of the course, it is thought wise to undertake a statistical survey of the foreign trade of the United States and of the broad divisions of the world. Here the goods of foreign trade are grouped into food-stuffs, raw materials, partly manufactured products, and manufactured goods ready for consumption. The countries of the world will group themselves according to the type of trade of each. Some countries, such as Chile, export one or very few raw materials, and import a variety of products. Other countries, such as England, import raw materials and foods, and export manufactured goods. The old question of industrial state versus agricultural state, which engrossed the statesmen and economists of Germany, will suggest itself at this point. The increasing importance of raw materials in our imports and of manufactured goods in our exports, leads to a discussion of broad historical tendencies in our own trade.

With this background of data and explanation, the student is prepared for a study of the middlemen and of the channels of trade used by the business man in the working out of these phenomena of trade. The danger in developing this part of the subject is that it shall become merely a description of a great number of middlemen and methods. Is there any guiding principle or system of classification which will correlate these subjects? All the people involved in foreign trade are directly

or indirectly concerned with getting the product from the producer to the consumer. Thus they do have a common purpose. Can we discover any essential parts of the task which have to be performed in every trade transaction? It was out of the attempt to find some key to the maze of specialists and methods that the functional view of marketing arose.

The functions of marketing may be grouped into (1) buying and selling functions, (2) functions of physical supply, and (3) certain incidental functions. The first group includes two functions, assembling and demand creation. Assembling refers to those activities which seek out sources of supply and set up business connections for buying. It includes also a study of the market to determine the proper time and place of purchase. The term does not refer to the physical transportation of the goods to the buyer, nor primarily to the physical concentration of the goods at a central market, although the organization of buyers and sellers in a great produce exchange certainly assists in the performance of this function.

Many middlemen in foreign trade perform this function and a few of them, such as brokers and export commission houses, have this for their principal task. The important point for the student to grasp is that as an essential function, it can be transferred from one middleman to another, or performed by the sellers or buyers themselves, but in no event can the function itself be eliminated.

The function of demand creation involves all the work of selling. This includes presenting the product to the attention of the prospective buyer in the most attractive light. The importance and difficulty of performance of this function vary greatly among different commodities. Thus it is much more difficult with jewelry, men and women's garments, and automobiles than it is with wheat, raw cotton, and steel rails. Generally speaking, it is more important in our exports than in our imports. This is undoubtedly one reason why in American business magazines we hear so much more about exporting than about importing.

The coffee, sugar, raw rubber, and silk which hold so large

a place in our imports, flow through well-organized channels from foreign producer to the American buyer; our exports of machinery and the many goods ready for final consumption require, on the other hand, a considerable amount of aggressive and active selling effort. This function is performed either by the seller himself, as in the case of the International Harvester Company and the Singer Sewing Machine Company, or by the export house or other middleman who may be acting in an independent capacity or as an agent of the seller. The tendency to direct marketing which is noticeable in certain lines calls for explanation and appraisal.

The functions of physical distribution include transportation, storing, sorting, and grading. These lead naturally to a study of ocean transportation and ocean freight rates. The storing function brings up the question of the relative desirability of manufacturing goods for stock, holding them in storage until demanded, or of manufacturing for order. In the one case, risks of price changes are assumed by the producer; in the other, the risk is shifted to middlemen and, in some kinds of goods, to the consumer.

The third class of functions includes financing and risk-taking. The financing function involves the extension of credit or, in other words, bearing the expense of accruing interest upon goods from the time of their production to the time of purchase by the final consumer. This function must be borne in the first instance by every middleman who takes title to the goods, although these men for the most part shift the function to banks or to other financial institutions. For the purpose of marketing-analysis, these institutions are designated as functional middlemen. The risk function leads to a consideration of insurance, especially marine insurance, and of speculation and hedging.

This sketch of the functions of marketing indicates the framework for a study of the trade organization, either in domestic marketing or foreign trade. The observations made in connection with each of the functions indicate the types of questions stressed. The object in treating each one of these functions is

to uncover some general tendency or some significant principle, rather than to describe the individual middlemen for their own sake.

The course concludes with a brief study of the relation of governments to foreign commerce. This subject, involving, as it does, ship subsidies, the encouraging agencies such as the Department of Commerce, various kinds of tariffs, reciprocity, free ports, and commercial treaties, deserves more extended treatment than can possibly be given in so brief a course.

It appears to the speaker that the university courses in business administration should aim to meet the needs of young men going into business, but for the most part they should not try to prepare men for specific vocations. They should develop a breadth of view and an ability to handle problems of business policy. As far as the university can help in developing these qualities, it will do so through giving an understanding of the fundamental nature of the business system. These ends can be best attained by building our new courses upon the foundations of the well-established work of general economics.

In conclusion, I wish to add a word concerning the public or social aspects of these business courses. Much of the development of economics, especially in the United States and Germany, has stressed the social control over industry. Undoubtedly, a certain amount of this is necessary, and in practice I would hardly join with those present advocates who are talking so loudly about removing the governmental shackles from industry. Nevertheless, it seems to me that perhaps even greater progress can be made in obtaining a higher productivity, and higher reward for various services of production, by encouraging the individual to pursue his own interest in a more intelligent manner.

If I understand correctly the attitude of the classical economists, they looked for social progress almost entirely from this self-seeking motive. But it must be remembered that they assumed that the business man would pursue his own interests *intelligently*, that he would know the costs of the various parts of his business, and that he would constantly be seeking more

efficient methods of production and distribution. The costs of distribution are high today, and much of the blame for the high prices of recent years has been placed upon the middleman. But, so far as the middleman is responsible, it is more largely a question of his efficiency than of his excessive profits. Little progress can, therefore, be made by government campaigns against profiteering.

Even if all net profits of middlemen could be eliminated, it would result in comparatively little reduction in the price of consumers' products. The surest road to lower costs of distribution is in an intelligent study of methods and distributive channels, with the immediate aim an increase of net profits to the business man, and the ultimate aim lower prices. The encouragement of this kind of study of business problems is the chief aim of our business courses.

University of Michigan

PROPOSED MODIFICATIONS AND RECENT TENDENCIES IN RURAL GOVERNMENT AND LEGISLATION

E. H. RYDER

Americans are prone to worship the past in matters of government. Nowhere is this fact more patent than in the persistence with which we adhere to the traditional organization of the county as a governmental agency. The present predominant form is the one which has prevailed from an early day when the population was distinctly rural in character. At that time such form was acceptable, but tremendous changes in functions have taken place in recent years without any measurable adaptation of the governmental organization.

Some specific efforts in this direction have been made, but with slight success thus far. For instance, in some cases the county and city boundaries have become coterminous, in which event one government is utilized. Another plan frequently found in practice is to effect better local government through more stringent state legislation. Conspicuous laws in this regard are the provisions for a budget system and a purchasing agent in the county. But criticism continues and the problem remains unsolved.

A few internal structural defects are chiefly responsible for much of this adverse criticism. In the first place, one may note the large number of elective officers which the voter must keep in mind. These officers are coördinate in powers and devoid of immediate effective responsibility to any superior officer. Again, the functions involved are far removed from the public eye, and are so elusive in nature that the average citizen realizes the existence and workings of county government less than in the case of any other form under which he is living. The city, the state, and the nation are more in the average citizen's eye than is the county.

The proposals for approaching this problem with a view of bettering the condition fall into four groups, which comprehend plans already tried or proposed for the near future.

In the first place, some individuals hope to accomplish the desired end by adjusting the present organization. For instance, the old fee system with its irresistible temptation to graft has been in some cases replaced by a system of fixed salaries. This, it is believed, will result in better service. Another plan is to classify counties according to population with the expectation that the state legislature will be able to enact legislation adapted to local needs. Illinois and Montana are examples.

Still another method has been to increase the powers of the board of supervisors with the hope that this board may be made an efficient administrative agency to which the various other officials may be made responsible. By far the most drastic as well as the most effective plan has been the creation of a county commission clothed with sufficient power to supervise the county affairs. Examples are found in the states of Indiana, New Jersey, Massachusetts and Ohio. Highly beneficial results are achieved by these plans, but experience shows no one of them to be an adequate remedy.

We now turn to some recent efforts in essentially new directions. A very prevalent means of bettering rural government, as found in thirty-four states in 1919, is the use of special municipal corporations to which are entrusted certain functions, many of them new and not readily related to existing agencies of rural government. Such corporations are made to include a definite area suited to the purposes for which they are designed. Voters are empowered to elect officers, levy taxes, and issue bonds, and are given such other powers as may be necessary and consistent. The most numerous types are suggested by the following: school, drainage, sanitation, water, road, forestry, light, heat, power, health, and fire.

The movement in behalf of rural health is conspicuous in these days in such states as Massachusetts, New York, Wisconsin, and Maryland. In these states health-districts are fully organized with full-time health-officers. California has per-

formed a conspicuous piece of work in the consolidation of her irrigation, reclamation, and drainage interests under a unified system. These efforts possess in common the merit of relieving the county organization of any necessity of performing these particular functions, although in many instances the county area is utilized for the purpose. The law of 1917 in Illinois, which provides that any combination of townships or of existing road districts may constitute a public health-district, is a conspicuous example of this tendency to utilize existing areas for new purposes.

The most interesting effort in this line is that of North Carolina as provided in an act "to incorporate rural communities." Under this act, a majority of the voters in a district embracing one or more school-districts may incorporate with the Secretary of State. A board of three directors is elected by the voters, which may adopt ordinances on the following subjects: public roads, schools, health, police, poverty, vagrancy, libraries, park play-grounds, fairs and other agencies of recreation, education, health, music, art, and morals. The board of directors may adopt standards for the protection and the marketing of produce, canned vegetables, etc., and may adopt labels, trademarks and brands, and regulate their use. A state bureau of community service is given supervision over these communities.

A parallel is found in Michigan today in the rapidly growing movement toward consolidation of schools. For efficiency, this involves an enlargement of a special area devoted to a single enterprise. Another related movement, which has some slight foothold, is that which fosters the organization of welfare areas in which citizens may direct and control their various interests, such as marketing produce, buying supplies, and activities of a social and recreational nature.

Another plan of very limited application has appeared in recent years under unusual situations. When a large city with thickly populated suburbs has developed in a county, a policy has been adopted in several instances — San Francisco, Denver and St. Louis — whereby the rural territory has been combined with that of the city under one government. This means the

abandonment of both the old city and old rural government and the substitution of a new plan applicable to the city and county united. This policy may find increasing vogue in the more populous industrial areas.

Finally, there is the plan of meeting the problem of rural government by the state's permitting the county to adopt the principle of home rule, with either a commission or a county manager to administer or direct the county functions. Obviously, this remedy owes its origin to the success with which the principle has found acceptance in a large number of cities in recent years. California was the first state in the Union to adopt this plan. It amended its state constitution so as to permit any county of the state to establish such a type of government. This was done in 1911, since which time four counties have drafted charters for the commission form.

Maryland in 1915 became the second state to amend its constitution in order to empower counties to frame charters. At the coming November election (1920), the people are to vote upon the first county charter as proposed for Baltimore County. Last fall a Charter Commission was elected. After six months this body proposes to submit to the people a county manager plan which introduces the following changes in government:

1. It abolishes the present county commissioners.
2. An elective legislative council of fifteen members is to take their place.
3. This council is to select a full time executive as manager for the county.
4. The executive work is to be distributed among three departments: (*a*) Department of Public Service, including highways, bridges, sewage, lights, public buildings; (*b*) Department of Finance, dealing with licenses, purchasing, receipts and disbursements, taxes; (*c*) Department of Public Safety, handling police, fire, health, general welfare work. Practically all functions except the judicial are to be placed in these departments by the Home-Rule Act of the legislature. The latter body is to withdraw

from this field of legislation and the county council must confine itself strictly to it.

5. The heads of these three departments are to be nominated by the county manager and confirmed by the county council for a term of four years. They are to be subject to the administrative authority of the county manager.
6. Nominations of these officers are to be made by petition, and election is to be by non-partisan ballot.

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CORRELATION AND THE PRICE OF COAL

A METHOD AND EXAMPLE OF MARKET-ANALYSIS

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THE GENERAL PROBLEM

Markets are complexes of many heterogeneous forces. In them these forces, arising from quite dissimilar sources, converge. Some few markets have one force which predominates. Most of them are guided by such a complexity of influences that it seems well-nigh impossible to resolve the tangle into its component parts. It is the intent of this paper to present a method of market-analysis which shall determine and evaluate the fundamental and permanent forces at work.

Some few markets can be satisfactorily analyzed by mere inspection. But in most cases, the very complexity of the situation makes it impossible for the investigator to do more than merely conjecture. It is the purpose of this paper to present a method by which the investigator may scrutinize and evaluate forces, not on a basis of his own assumptions, but with a measure of scientific precision. The method employed is a mathematical one known as correlation. The first part of this paper is devoted to the theory of correlation, omitting the mathematical details involved; the second part deals with the specific application of this method to the bituminous coal industry.

THE THEORY OF CORRELATION

If a careful comparison of two groups of phenomena demonstrates that the variations in one correspond to variations in the other, we say that correlation exists between them. For example, inasmuch as examination shows that an abnormal amount of iron ore is mined in years when there is also an ab-

normal production of steel rails, correlation exists between the production of iron ore and steel rails. Again, if by examining one thousand anthropometric charts it is found that the taller men are the heavier, then correlation exists between height and weight.

But it is not always easy to recognize such correlation. Imagine examining the records of five hundred cows in an effort to determine the relationship between the amount of feed per cow and the amount of butter-fat each produced. In such a case as this, where a great number of instances are employed, even graphic methods prove inadequate. But not only must we be able to recognize correlation, we must be able to evaluate it. For this purpose Karl Pearson, the eminent biologist, evolved the correlation coefficient.

This coefficient is an evaluation of the relationship between the variations of two groups of phenomena. It is an absolute number, i.e., it is not influenced by the size of the units, nor by the extent of the deviations of the data employed. It may range from + 1 to − 1. A correlation coefficient of + 1 indicates perfect direct correlation, with the two always fluctuating regularly in the same direction. A coefficient of zero indicates no correlation present. A coefficient of − 1 indicates perfect inverse correlation, with the fluctuations similar, but in opposite directions.

If, for example, we had the measurements for a number of students, and found that *in every case* an additional inch in height meant five additional pounds in weight, we could say that a correlation of + 1 existed. Although this is obviously not true, yet some direct correlation between height and weight does exist. Actual investigation might value this at + .6. To give an actual example, the correlation between the amount of coal produced and the number of days worked in the mines per year is + .926. In other words, fluctuations in the amount of coal produced and the number of working days are very similar.

Again, take a case worked out by H. L. Moore. The correlation between the annual change in the amount of potatoes pro-

duced and the change in price is $-.856$. This means, then, that the fluctuations are simultaneous, but opposite; that a small price corresponds to a large production and vice versa. The correlation coefficient, then, is a measure of the relationship between the two groups.

But what does the existence of this relationship signify? It can have only three sources: first, it may be the result of the dependence of one variable upon the other, for example, the correlation between iron ore and steel rails, or the heights of fathers and sons; secondly, it may be caused by the dependence of both variables on some third factor, as the correlation between the hay and corn crops, due to the fact that both are dependent upon rainfall; thirdly, it may be purely fortuitous.

If we find that a relationship does exist, how can we tell whether it is organic, or merely the product of chance? The reliability of the correlation coefficient depends upon two things, the size of the coefficient itself and the number of observations made. Obviously, the larger the coefficient, the more certain one can be that an actual causal relationship exists. If, however, only a few examples have been considered, this high correlation co-efficient may be based on a purely fortuitous similarity of variations.

But if, as we expand our data, and find that, when we take more and more instances into consideration, the relationship remains as indicated, the probability of its being fortuitous rapidly grows smaller. For example, if a man throws "double-sixes" twice in succession, it signifies little. If he does it four times in succession, some might question; the throwing of "double-sixes" ten times in succession would cause most people to feel that it was not purely fortuitous, and lead them to examine the dice very carefully. As the number of instances increases, then, any relationship evident becomes more and more firmly established as causal and not fortuitous.

To sum up, the reliability of the results depends upon the size of the correlation coefficient and the number of instances employed. The correlation coefficients given in this paper are based upon twenty-eight items; in them, a coefficient of less

than .300 may be disregarded, but one of more than .500 indicates in general a decided causal relationship.

CORRELATION IN MARKET-ANALYSIS

And now, with this method of determining the strength of the connecting bond between variables, we are ready to attack the problem of market-analysis. Just what can our correlation coefficient do in the midst of the complexity of market forces? It may be used to determine the relationship of the fluctuations of one of these factors, such as supply, over a period of years, with those of other data to be explained, for example, price. The correlation coefficient can weigh these two sets of fluctuations and evaluate the relationship actually existing. It deals with them as they have acted in the dynamic situation, in the midst of all the other forces.

If the factor in question is of so little importance, or is so regularly offset by some other factor, that it has little influence on the variation of the data which we are analyzing, this lack of connection between the two is made apparent in a low correlation coefficient. On the other hand, if this factor is really influential, and is constantly exerting pressure on the other, there will naturally be similarity between their variations, and this will be demonstrated by a high correlation coefficient. Thus, correlation will evaluate the relationships as they have actually existed.

One must constantly keep in mind, however, the fact that the correlation coefficient does not explain. It merely states the fact that a relationship exists. It remains for one who has studied the market under consideration to interpret and explain the relationship disclosed.

THE SPECIFIC PROBLEM

Having set forward a method for market-analysis, let us apply it to an actual case, the mine-operators' or producers' market, the first step in the marketing of bituminous coal. This is an especially interesting case because the market is so

unorganized that the usual descriptive method proves absolutely inadequate. Another slight argument in favor of its use, is that reliable data are available, all of which come from government agencies.

THE DATA EMPLOYED

The data employed cover each year from 1890 to 1918 and are as follows:

Supply. — The total quantity of usable fuel in net tons produced for each year, being the summation of coal shipped from the mine, coal made into coke at the mine, coal sold to local trade and employees, and coal used at the mine for steam and heat.

Price. — The average realization value at the mine f.o.b. cars. This is based on reports made by the operators to the U. S. Geological Survey, stating amounts received for coal sold and estimated exchange value for coal not sold. The change in general price level has been eliminated by expressing these prices in terms of the 1913 dollar by means of the index numbers of the U. S. Bureau of Labor Statistics.

Demand. — A composite expression based upon the conditions which determine the use of coal each year.

Since twenty-eight per cent of the coal is consumed by railroads, fifty per cent by industrial establishments, and sixteen per cent by domestic users, variations in the demand for coal result from fluctuations in railroad transportation, the general business situation, or in domestic demand. The fluctuations in railroad transportation may be represented by variations in total freight-ton miles per year; the fluctuations in business conditions by the amount of pig-iron produced; and the domestic demand by the temperature of the winter months, which also conditions the other uses to some extent. By properly weighting these three items, and combining them, a composite is obtained which is the expression of the demand in terms of the conditions which determine it.

Through the use of data expressing annual fluctuations only, the variations of the market due to purely temporary forces

have been largely eliminated. It is necessary, however, to remove the secular trend also. In the matter of production, for instance, we find a steady increase from year to year, due to the growth in population and the expansion of industry. It has seemed best to eliminate this by expressing each variation in terms of the percentage change from the previous year.

To make sure that such a method involves no substantial error, I have worked out all results on a basis of first variate differences, and also variations from a nine-year moving average, and obtained approximately the same results. Both these latter methods involve, however, errors which make the method of percentage differences appear to be the most accurate. If we do express each year of coal production as a percentage of the previous year, we find that there is an average increase of six and four-tenths per cent. Were there no other influences present, the production would increase regularly at this rate. But in some years it increased more, in others, less. For our purpose, any increase more than six and four-tenths per cent will be considered an increase in production, and any less than that a decrease in production. Our problem is the analysis of these fluctuations about what we might call the "normal trend" of the data.

The application to the data of the method just stated gives the following results.

RELATION OF DEMAND AND SUPPLY

The correlation between demand and supply is expressed by a coefficient of + .742. Obviously, this denotes a marked similarity between their fluctuations. In other words, production of bituminous coal conforms very accurately to the demands of the market. But which way does the causation run, from demand to supply, or from supply to demand? This can be answered by recalling the composition of our demand expression. For a large amount of coal produced will have, at most, only a slight influence on the amount of freight-ton miles, since coal is only one of the many factors determining the

amount of freight carried. An increase in the amount of freight carried will, however, have a great effect on the amount of coal produced. Likewise, an increase in the amount of pig-iron produced will not be the result of an increase in the amount of coal produced, but rather a cause for the production of more coal.

As for temperature, it would take an enormous increase in the production of coal to affect it in any way, whereas a small increase in the temperature will have a decided effect on the amount of coal produced. In other words, since the demand is determined by many outside factors quite independent of the supply of coal, the line of causation runs almost entirely from demand to supply. That is, the demand is determined externally, and the supply conforms to it.

If pig-iron and freight alone be considered as determining demand, the correlation between demand and supply becomes + .863, in which case the fluctuations were similar in twenty-four of the twenty-eight years under observation.

Other interesting facts can be noted as the correlation coefficient is developed, e.g., that since 1906 there has been much greater conformity between supply and demand than before that date. This would indicate that the market became better organized at that time, or possibly that new methods of marketing were introduced.

RELATION OF DEMAND AND PRICE

Upon introducing price into our discussion, we find that the correlation coefficient between supply and price is – .090, and that between demand and price is – .243. That the latter is so high is due to the peculiarities of the temperature variations, for if temperature be not considered, the correlation between demand and price becomes – .087. These are negligible. Apparently, then, neither changes in supply nor changes in demand have any effect on price. Does this mean that supply follows demand so closely that the price is not affected by variations?

We know, however, that price does vary. Why? The reason is soon seen in the market itself. Coal is sold either by

contract or in open market. Since eighty per cent of the coal is used by railroads, public utilities, and large industrial establishments, and since they can foresee with considerable accuracy their demand, a system has grown up whereby these large buyers purchase almost all their coal on annual contracts, and enter the spot market only under abnormal conditions. Likewise, the jobbers get their coal on contract, so that much of the spot market coal is contract coal as far as the producer is concerned.

These contracts are generally for the coal year, April 1 to March 31. Consequently, the producer's market for coal is chiefly a contract market. A fluctuation in demand cannot influence the price until the contract then in force expires. Therefore, we should expect the fluctuations in price, instead of correlating directly with fluctuations in demand, to lag considerably behind. This hypothesis is tested by correlating the demand of 1890 with the price of 1891, the demand of 1891 with the price of 1892, etc., as a result of which is a correlation coefficient of + .684. This is not saying that a big demand would not affect the price you have to pay for coal (it certainly would), but that, as far as the actual producer is concerned, his output is already contracted for, and he will not benefit from these higher prices until the new coal year, when new contracts are entered into. It is interesting to note that this rule has held without a single failure since 1906.

RELATION OF SUPPLY AND PRICE

As already noted, the correlation between supply and price of the same year is – .090. By lagging the price one year, however, as we did when correlating demand and price, we find that a correlation of + .569 exists. This is especially interesting when compared with the same correlation in the cotton market which is – .812. Why is it that the coal market should reverse the situation and a large supply be followed by a high price?

There are two possible explanations for this large plus coefficient. First, coal may be an industry entailing increasing

cost, and the mining of this great supply, involving a big expenditure, may have caused this high price. Let us use our method in testing this hypothesis. New data must be introduced which may be called labor cost. This represents the amount of labor required to mine one ton of coal. The estimate is made by dividing the product of the number of days worked and average number of employees, by the number of tons produced. Since labor is from sixty to eighty per cent of the total mining cost, a variation in amount of labor required would be the greatest factor in variations in the cost of mining. But the correlation existing between labor cost and amount produced is only + .208. This by no means justifies the hypothesis that increased production is accomplished only at increased cost.

A further examination of the data brings out some illuminating facts. If the supply of one year and the labor cost of the following year be considered, there is a correlation of + .556. There is, therefore, a real relationship between supply and cost, but with a time element introduced. Apparently, the producer knows that he is to have this larger cost, for the price which is set early in the year and which must consider the estimated cost of production, shows a relation to this cost of the same year of + .378. Now comes the question, Why does this increased cost come the year after the large production rather than the same year?

There seem to be two factors in this relationship. *First*, there is a natural delay. This labor cost is affected by the number of men employed. As production increases, the number of men will remain the same for a while, and then increase. Similarly, as the amount produced decreases, the same number of men will be employed until there has been a considerable decrease. Consequently, the labor cost would naturally fall behind production. Secondly, much of the mining cost is in the opening up of new seams, etc. In the year of great production, all easily available coal is mined, so that, during the following year, a considerable amount of labor must be employed in opening up new seams, thereby resulting in a higher labor cost. In

other words, the increased cost is not that of producing the large amount of coal, but of regaining the ground lost by this large production. At any rate, it is true that a large supply results in a high cost for the next year, and this enters, to some extent, into the determination of price.

This is not sufficient, however, to explain the large coefficient which we found between supply and price. The second reason, and the most important one, is as follows. In the discussion of the theory of correlation, the statement was made that correlation might be the result of a direct line of causation, or of influence upon both variables by the same force. This latter alternative is the real explanation of this large plus coefficient; for demand is an independent variable, coming into the market from outside. Its fluctuations determine the supply for that year and also the price for the next year. Is it not, consequently, to be expected that there will be a great similarity between the supply one year and the price the next, though there be no direct connection between them? There is no direct line of causation between supply and price. There is a similarity of variations because both are determined by demand. There is a small indirect line of causation from supply to price through cost of production.

SUMMARY OF THE SPECIFIC PROBLEM

Demand is the predominating force in the bituminous coal market. Supply conforms very closely to demand. This demand is the result of business conditions, railroad transportation, and temperature. Demand does not influence price until the following year. This is due to the system of contracting now prevalent. Supply enters into price-fixing only as it influences the cost of mining in the following year.

These are the forces which have been active throughout the last twenty-eight years. In this paper, I have considered only these most important factors. It would be possible to extend the investigation to include relations of profits, wages, cost of materials, strikes, car shortages, introduction of machinery, etc.,

to market conditions. Such extension must be made in order to obtain a complete analysis.

SUMMARY OF THE GENERAL PROBLEM

As we approach nearer to standardization and regulation of markets, it is essential that we have a satisfactory means of market-analysis. Our general theory of markets has been fully developed. It now remains for the economist to consider these general principles and qualify them in the light of each separate market. By the use of a quantitative study, the means for which I have suggested, he can now make a complete market-analysis. If this method succeeds in such an unorganized market as that for bituminous coal, it ought to be of even greater value in those which are more standardized and highly organized.

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AN ABSTRACT OF "A HISTORY OF THE MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY BY R. C. ALLEN AND H. M. MARTIN"[1]

HELEN M. MARTIN

The Geological Survey of Michigan is almost as old as the State itself, having been founded by Act 20 of the Legislature of 1837. Dr. Douglass Houghton was appointed state geologist, but the First Survey terminated in 1845 with the untimely death of Dr. Houghton. In 1859, by Act 206 of the Public Acts of 1859, the Legislature provided for the resumption of the Geological Survey, but the outbreak of the Civil War interrupted the work of 1861; it was not until 1869 that the Third Survey was organized under Act 65, 1869, the law under which the Survey now operates.

In the accounts of the Jesuits, there are disconnected observations on rocks and minerals and soils of the region of the Great Lakes, as well as notes and descriptions of routes of travel, mainly along waterways and the coast of the Northern Peninsula. These descriptions were chiefly geographic in character, as were those of other early explorers, Alexander MacKenzie in 1789, General Cass in 1819, Major Long in 1823, and H. E. Schoolcraft in 1831.

To Douglass Houghton and his assistants of the First Survey, we owe the earliest organized statements concerning the geology of Michigan. In 1837 Michigan had fewer than 24,000 white inhabitants, located mainly about Detroit and Saginaw. To many of these people, as well as to the people of the East, Michigan was a land of muskeg swamps and sand-hills. It was largely to eradicate these ideas that Douglass Houghton planned the first survey.

[1] The contribution by the first author covers the years 1837–1872, by the second, 1872–1920.

Although organizations of the first surveys of Massachusetts, Tennessee, Maryland, New Jersey, Connecticut, Virginia, Maine, New York, Ohio, and Pennsylvania preceded that of Michigan by one to seven years, their results were as yet so meagerly available that they were of little aid to Dr. Houghton in planning those labors that were to open up the wilds of Michigan. It is interesting to note here the evidence of Houghton's vision and genius, that the Survey as organized by him (Act 49, 1838) is in the main essentials the plan existing today in Michigan and a number of other states. Its plan provided for geological, topographical, zoölogical, and botanical departments, each in charge of a specialist under the direction of the state geologist.

Since the idea of Federal and State coöperation is supposed to have originated in connection with making a topographic survey of Massachusetts, and to have been the idea of Mr. Henry F. Walling, it is interesting to note in passing that in 1844 a contract to make such a survey was entered into by Douglass Houghton and the Federal Land Office.

Straitened finances and the hostility of the Legislature caused the abolishment in 1840 of the Departments of Botany and Zoölogy, over the strong but futile protests of Dr. Houghton. The Legislature could see no early benefits from such labors.

The law of 1837 contemplated the completion of the Survey in four years, but it was soon apparent that a long time would be necessary to make even a cursory examination of the entire State. The incompleteness of the United States linear surveys hindered the work. Nevertheless, a large part of the field-work was accomplished in 1842, when the act creating the Survey expired, leaving a large part of the Upper Peninsula unexplored. Dr. Houghton, therefore, set about effecting a plan of connecting the linear surveys with the minute geological and mineralogical surveys of the country. In 1844 he laid his plan before the Government. Its feasibility was comprehended and Houghton given the contract of running 4,000 miles of lines at a price but little, if any, exceeding that which would have been paid for a linear survey alone.

The plan was abandoned after his death, but had the system remained in operation, we should have had at that early date information which was acquired decades later, and with vastly greater expense and labors. The published results of Houghton's survey appear in seven reports to the Legislature and in a number of short communications relative to the development of salt-springs and other subjects. (This we expect to be re-published, together with a more complete history of the survey, in a forthcoming volume issued by the Historical Commission.)

The final report was nearing completion when it was interrupted by the death of Dr. Houghton October 13, 1845. The state topographer immediately impressed upon the Legislature the importance of entrusting the completion and the editing of the final report to Dr. Houghton's assistants, but though the Legislature responded by authorizing the governor to appoint a suitable person, no appropriation was made for his expenses and remuneration. There is no record of such an appointment, and certainly the work was not done. The vast collection of notes, maps, and manuscript, representing eight years of unremitting toil, was lost. Dr. Winchell reports that the administrators of Dr. Houghton's estate employed William A. Burt and Bela Hubbard to compile from the field-notes of 1845 results of the great work of that year. These reports were not published, but were undoubtedly incorporated into the Jackson report of 1849–1850 without proper acknowledgment to Dr. Houghton.

Just how much was accomplished by Houghton is not known, but it is evident from fragmental reports in House and Senate documents that he had attained a fairly clear understanding of the succession and structure of the Palaeozoic rocks, had blocked out the Michigan Coal Basin, understood in a measure the later history of the Great Lakes, and had traced the position of their shore lines, had called attention to the importance of the deposits of natural brines, gypsum, coal, peat, marl, clay, limestone, iron ore, and copper, and had discovered gold. The influence of his report on the copper-bearing rocks was a factor in attracting capital to the Copper Country and in exercising

a wise guidance on early prospecting and financial operations, and also in hastening the construction of the first canal and locks around the falls of St. Mary's River. The entire cost of the Houghton Survey was $32,829.03.

A little more than a year after the suspension of the survey under Dr. Houghton, Congress passed an act embracing provisions for the geological exploration of the Lake Superior Land District organized by the same act. Under this act, Dr. C. T. Jackson was appointed to execute the required survey. During two field-seasons, he prosecuted the work, then presented his report of 801 pages and resigned. The work was continued and completed by T. W. Foster and J. D. Whitney. These reports appear as U. S. Senate Documents. Some of the assistants of Dr. Houghton were employed by Jackson, Foster and Whitney, and Houghton's notes and results were made use of in other ways to such an extent that much of the credit rightfully belongs to him, though no proper acknowledgment of it is made by these geologists.

The Second Survey was inaugurated in 1859, Act 206, and suspended in 1863 by the failure of the Legislature to make an appropriation for its continuance. The act authorizing the Survey was almost identical with that of 1837, empowering the governor to appoint a suitable person to finish the geological survey of the State and to furnish "a full scientific description of the rocks, soils, and minerals and of its botanical and other natural productions."

Dr. Alexander Winchell, the professor of geology in the University, was appointed state geologist by Governor Wisner, March 9, 1859. In December, 1860, Dr. Winchell made a report to the governor under the title *First Biennial Report of the Progress of the Geological Survey of Michigan*. This is the only publication of the Second Survey and is without map, sketches or other illustrative material, omissions which impair its usefulness. Evidently, the Legislature disapproved the emphasis placed on the botanical and zoölogical investigations, for by Act 64 of 1861, the state geologist is directed to restrict his labors to the geological department exclusively.

The report records the activities of Dr. Winchell and his assistants, as well as the results of their labors. In this document, Dr. Winchell gives the only orderly and connected general account of the State which had been made. He dismissed the non-fossiliferous rocks west of the meridian of Marquette with a brief statement of the works of other geologists. But the fossiliferous rocks were studied carefully by him. The report describes them in considerable detail and compares them with similar formations elsewhere. Dr. Winchell made a large collection of fossils, studied the non-metallic industry of the Southern Peninsula, and made a catalog of its plants, mammals, birds, reptiles, and molluscs.

The First Survey was devoted mainly to the Northern Peninsula, the Second to the Southern. When it is considered that the work extended but a little over two years, that the appropriations were small, and that the time Dr. Winchell was able to devote to the Survey was limited by his university duties, it is not surprising that the published results were not numerous.

The Second Survey was definitely terminated by the Legislature by joint resolution of the House and Senate which directed the "late state geologist to transfer to the Board of State Auditors all property of the survey, etc." The total appropriation for the Second Survey was $9,000, of which only $6,000 was drawn from the treasury.

By the year 1869, a strong public demand had arisen for a resumption of the geological survey, and Governor Baldwin in his annual message strongly advocated "a thorough comprehensive examination of the whole State." In due time a bill authorizing its resumption was introduced by Mr. Yawkey; it was referred to a joint committee of the House and Senate. The report of this committee reviewed the previous geological work in Michigan and legislation concerning it, and concluded with a very urgent recommendation that a most comprehensive and detailed survey be made — if not in both peninsulas, at least in the Northern. The bill embodying these recommendations, *Act No. 65, Public Acts 1869*, was promptly passed March 26, 1869.

The act created a Board of Geological Survey, an ex officio body consisting of the governor, the superintendent of public instruction, and the president of the State Board of Education. The Board was authorized "to appoint a suitable person possessed of the requisite knowledge of the science of geology who shall be Director of the Survey," and, at the nomination of the director, such assistants as were necessary to fix salaries and in general "to regulate all expenses incident to the survey."

The director was charged with all responsibility for the scientific and administrative work of "a thorough geological and mineralogical survey of the State, embracing a determination of the succession, arrangement, thickness, and position of all strata and rocks; the mineral character and contents and their economical uses; an investigation and determination of the organic remains of the State; a general examination of the topography, hydrography, and physical geography of the State; an investigation of the soils and subsoils, and the determination of their character and agricultural adaptation; the investigation of all deposits of brine, coal, marl, clay, gypsum, lime, petroleum, metals and metallic ores, building stones, marble, grit stones, materials for mortar and cement, mineral paint, and all other productions of the geological world capable of being converted into the uses of man."

The act provided for a continuing annual appropriation of $8,000, and directed that one-half of the expenditure be devoted to work in the Northern Peninsula, including the "collection of statistics and history of the mineral, manufacturing, and transportation interests; to the preparation and compilation of accurate maps showing the topography, geology, and timber, and also portions of mines, roads, and improvements; to the determination of the position and structure of the minerals and mineral rocks; to compiling and collecting of all useful knowledge that would be of practical value in finding and extracting ores and mining and smelting in the districts of the Upper Peninsula known as the iron and copper regions."

A joint resolution of the House and Senate was passed asking Congress to appropriate annually for three years $8,000 to

assist in making the survey, but the request proved futile. It is noteworthy that there was no provision made for botanical and zoölogical investigations.

On April 24, 1869, a month after the act became effective, Dr. Alexander Winchell was for the second time appointed director of the Survey. But Dr. Winchell's second administration was destined, like the first, to be short-lived. The causes which led to his resignation are not known. His brother states they were of a political nature. At any rate, the Board seriously disagreed with Dr. Winchell in regard to the scope and management of the Survey. Dr. Winchell could not be reconciled to the decisions of the Board and tendered his resignation March 21, 1871. Dr. Winchell presented a very comprehensive plan for the completion and publication of the results of the survey, which the Board would not accept. The history of the work during the next twenty years is a demonstration of the unwisdom of the failure to carry out Dr. Winchell's plans.

During the two years 1869–1871, Dr. Winchell and the Board interpreted the clear intention of the law "that the moiety assigned to the Upper Peninsula should be expended in the development of the iron and copper interests of that part of the State," and decided that, in view of the limited means, it was wise "to devote the entire annual moiety to the iron interests in 1869, and to the copper interests in 1871." Accordingly, a contract was signed with Major T. B. Brooks by which he was required to complete a survey of the Marquette Iron District; for this he was to receive $4,000. A similar contract was signed the following year with Prof. E. J. Pumpelly, by which he was required to conclude such portion of the survey of the copper region as could be accomplished with the desired degree of unity and completeness for the other $4,000." The work of Major Brooks began June 4, 1869, and continued through 1871. The work of Professor Pumpelly began June 1, 1870.

In the Northern Peninsula, the areas actually subjected to examination were the Copper District of Portage Lake; the Marquette and Gwinn Iron Districts; St. Mary's Peninsula; the

Green Bay region; and in the Southern Peninsula the Cheboygan, Little Traverse Bay, Thunder Bay, Au Sable River regions, the valleys of the Manistee and Pere Marquette rivers, Kent and Lapeer counties, and many other smaller districts. Investigations were made of the fish, lumber, and forests of the east and west shores, and of the fruits of the west-shore district, as well as of some meteorological problems.

Dr. Winchell planned and, in great degree, assembled the material for a series of publications on the physiographical features of the State, its general geology, economic geology, resources, palaeontology, zoölogy, botany and antiquities, which would have been of the utmost value in the development of the State.

Dr. Winchell asked an appropriation of $60,000 with which to complete the work he had mapped out, but his plan and hope failed. He could not accept the plan of the Board to "give the survey a more practical direction and to secure more direct and immediate benefit." The Board had not the vision nor the scientific insight to accept Dr. Winchell's plan and accepted his resignation April 17, 1871, and the same day appointed Dr. Carl Rominger to continue the survey of that part of the State not included in the investigations of Major Brooks and Prof. Pumpelly.

In the meantime, the Board had proceeded to have the law changed (*Act 179, Public Acts 1871*) in such a way as to abolish, not only the powers and duties of the director, but also the office itself, and to center the full responsibility as well as authority in the Board. The Legislature amended the law in accordance with the desires of the Board, at the same time repealing the provisions requiring an equal division of the work and expenditure between the Northern and Southern peninsulas. In other respects the law remained unaltered.

In 1871–1872, Dr. Rominger completed a survey of the Palaeozoic rocks which cover the western end of the Northern Peninsula from Marquette to St. Mary's River, and the studies of Brooks and Pumpelly were brought to a close. In 1874, the results of these studies were published as Volume I of the Sur-

vey reports, viz.: *Iron-Bearing Rocks*, by Major T. B. Brooks; *Copper District*, by Raphael Pumpelly and assistants; *Palaeozoic Rocks*, by Carl Rominger (Volume I is accompanied by a geological atlas, sections and statistical data); and Volume II, containing a lithological description of specimens of rocks, by Alexis A. Julien, Major Brooks, and Chas. E. Wright. The appearance of these reports marks an epoch in the study of the geology of the Northern Peninsula. Twenty-one years had passed since the reports of the Jackson-Foster-Whitney surveys had been given to the public.

In the interim, a few articles on the general geology appeared in certain periodicals, but no considerable advance in understanding of the general geology of the Northern Peninsula had been made. The studies of Pumpelly and Brooks were based on those minute observations which have characterized nearly all subsequent works in the region. Pumpelly's *Paragenesis of the Minerals Associated with Copper* is one of the classics of geology, and Marvin's *Detailed Structure and Stratigraphic Sections* remains even today a standard for comparison and correlation of the formation members of the vast thickness of sedimentary beds and lava flows of the copper-bearing series of Keweenaw Point. Brooks's report was devoted mainly to the economic aspects of iron mining and smelting; nevertheless, a great advance was made in his studies of the structure and succession of the Huronian system of the Marquette Range.

Brooks was the first to perceive that the Marquette Range is a great synclinal trough forty miles in length, pitching westward from the vicinity of Marquette. In company with Pumpelly, he also made reconnaissance examinations of the Gogebic range from Penokee Gap in Wisconsin eastward to Lake Gogebic in Michigan, and determined correctly the relations of the Laurentian, Huronian and Keweenawan systems in this range. Numerous details of the geology of the Menominee and Felch Mountain ranges were also given. Rominger's report on the Palaeozoic rocks is the first comprehensive description of the geology of St. Mary's Peninsula, and maintains the high standard set by Pumpelly and Brooks.

During the four years 1872–1876, Dr. Rominger was engaged practically alone in the work of the Survey. The results of his researches are embodied in Volume III of the Survey Reports, which are a discussion of the geological structure of the Southern Peninsula, confirming and carrying farther the views and researches of earlier geologists, Houghton and Winchell, on the "basin structure" of the Michigan area. The book contains also the record of the state salt-inspector, Dr. S. S. Garrigues, and also by far the most important record of Dr. Rominger's studies, a carefully elaborated monograph on the indigenous fossil corals of the State, the first treatise of a state survey devoted wholly to corals.

In the spring of 1877, the Board of Geological Survey, although comprehending the valuable and arduous work of earlier geologists, realized that investigations were only commenced, and that it should be the duty as well as pride of the citizens of the State to have the territory fully examined. Therefore, the Board accepted, Dr. Rominger's plan to make careful detailed examinations of certain small circumscribed areas so related as to embrace the most important rock formations developed in the region. This work, like all work before and practically all since, was hindered and delayed by lack of topographic maps, and the necessity of depending on the government maps of the linear surveys of the United States, upon which the topography was omitted or inaccurately recorded. The need, however, for topographical work, as well as for general reconnaissance, resulted in the discovery of many "instructive" outcrops, which would otherwise have been overlooked.

Three summer seasons were spent in the investigation and construction of a special geologic and topographic map of the district about Marquette, Negaunee and Ishpeming. Dr. Rominger also examined the then important mining localities, Washington, Champion, Republic, Spurr, and Michigamme. The season of 1880 was spent in a similar careful examination of the Menominee region. (The reports are published as Volume IV.) During 1884, the state geologist continued work in the copper and iron country, but although the report of the work

would have been of value to the mining companies, it was so small that the Board deemed it inadvisable to print it, and it did not reach the public until ten years later.

Dr. Rominger continued as state geologist until May, 1885, when he was succeeded by Mr. Charles E. Wright of Marquette, who had been commissioner of Mineral Statistics since 1878 and a member of the Board of Control of the Mining School at Houghton.

Mr. Wright remained state geologist until his death in 1888. During the field-season, he was engaged in making topographic maps and sketches to illustrate the geology of the Northern Peninsula, and in the collection of 3,300 specimens of rocks to be the nucleus of the collections of the University and various colleges. In the Southern Peninsula he visited the salt wells and prepared sixty sections of deep borings. But at the time of his death, in spite of zealous labors to fit himself for the position of state geologist by years of research and study, and in spite of his plans and work laid out on a large scale, nothing was available for publication and many facts and conclusions reached by him were lost to the public.

Upon the death of Mr. Wright, the Board responded to certain pressure brought to bear upon it and appointed Dr. M. E. Wadsworth, director of the Mining School, as state geologist. An arrangement was made with the school whereby Dr. Wadsworth was permitted to manage that institution, and at the same time act as state geologist. That such a union of offices was unwise was brought to the attention of the Board, but the inadequacy of the Survey funds available was deemed sufficient reason for carrying out the plan.

With Dr. Wadsworth, the Survey at last secured offices of its own. Up to that time, the Survey had had no other habitation than the private offices or homes of the various geologists. In May, 1889, the Mining School gave a room, rent free, about 25 by 30 feet in size, in which the indoor work could be prepared, and in which was stored all property of the Survey except manuscripts and published volumes. The school also allowed the Survey unrestricted access to and use of all depart-

ments and laboratories, thus providing a means of more rapid indoor work, analysis and preparation of specimens and thin sections, map work, etc., which should have hastened publication of reports.

Dr. Wadsworth continued Wright's plan of detailed surveys of the iron districts, exploring in 1888 between Iron River and Gogebic Lake, and between the state boundary and Township 46 on the north, and in mapping unsurveyed districts near the Marquette district; and in 1889 extending the exploration westward from Lake Gogebic to the state boundary, and in exploring the eastern boundary of the copper-bearing rocks.

In 1889, arrangements were made with the U. S. Geological Survey, whereby the State Survey devoted its time mainly to the economic geology of the State, leaving the purely scientific studies, particularly palaeontology, to the U. S. Survey. Upon the recommendation of Dr. Wadsworth, the Board voted to correspond with Prof. Mendenhall, superintendent of the Coast and Geodetic Survey, asking him to undertake a triangulation of the State, but, apparently, nothing further was done to aid the inauguration and progress of the much-needed topographic survey.

The Board of Geological Survey of 1890–1892 seems to have taken a lively personal interest in the work of the Survey. They accepted Dr. Wadsworth's very ambitious plans, but from the minutes of the meetings it is very evident that they were "dissatisfied and disappointed" with the slow output of material for publication, and the fact that thin sections and specimens were not being prepared and sent to the various schools and colleges with greater rapidity. The Board visited the offices of the Survey at Houghton. At a joint meeting with the Board of Control of the College of Mines, it was decided that Dr. Wadsworth should be released from his duties as director of the college from August, 1891, to May, 1892, "to such an extent as was necessary to enable him to complete the work to date."

The Board also requested Dr. Wadsworth to furnish an annual report not later than Jan. 1, 1891. In this request the

Board was disappointed, and the somewhat acrimonious correspondence which followed led Dr. Wadsworth to tender his resignation March 3, 1891. This was not, however, accepted, and, furthermore, a sharp communication was sent informing him that unless material required for the annual report was forwarded by April, the Board "would move its property to Lansing, discharge its present employees, and employ such others as it saw fit."

A committee was appointed to visit the state geologist and to ascertain progress on the report. The results of this investigation and recognition of Dr. Wadsworth's plea "that suspension of the operations of the Survey would result in putting back the publication for many years, or, more likely, cause the loss to the State of the past ten years' work," caused the Board to retain Dr. Wadsworth as state geologist, and to write to him that their differences had arisen from a misunderstanding of the amount of work to be completed, and that "the Board further reports that Dr. Wadsworth has the Survey thoroughly organized, and, *so far as the time given the Survey permitted*, is making considerable progress."

Although most of the papers comprising Volume V were in the hands of the Board in June, 1892, despite the fact that it was the lack of published reports which had urged the Board to its singular activity, the Board retired with the volume unpublished, printing only the *Report of the State Board of Geological Survey for 1891 and 1892.* To this are appended exhibits setting forth the expense of the Survey, the reports of Dr. Rominger, Mr. Wright and Dr. Wadsworth. This is the first and only report made by a Michigan Board of Geological Survey, and the only contribution of the Wright-Wadsworth administration. As it is without maps or illustrations, it is of much less value than it otherwise would be.

In the report, the Board includes recommendations for certain remedial legislation which were significant of future changes in the conduct of the Survey: first, that a room in the Capitol be set aside for the Geological Survey; second, that the appropriation be increased so that the entire time of competent geolo-

gists could be secured, thus paving the way for offices in Lansing with a director of the Survey both independent of Mining School and University, for the placing of the finances of the Survey on a plain business basis when the work of the Survey should no longer be hindered by the divided interests of the director, but the compensation of the director be such that he could devote his entire time to the Survey. A recommendation to abolish the office of commissioner of Mineral Statistics and transfer his duties to the Survey, brought results twenty years later. The Legislature took no action at that time, but eventually the recommendations were carried out and the successors to Dr. Wadsworth devoted their undivided efforts to the Survey.

The succeeding Board acted upon the recommendations of their predecessors to the extent of considering legislation to incorporate the office of Mineral Statistics with the Survey and to appoint a state geologist independent of the College of Mines. Informed of this, Dr. Wadsworth offered to resign as president of the Mining School and devote his entire time to the Survey, if his compensation would be placed at $4,000 a year. The Board did not accept Dr. Wadsworth's proposal, and in July, 1893, appointed Dr. Lucius L. Hubbard of the Board of Directors of the Mining School to the office of state geologist, and Dr. A. C. Lane as assistant state geologist.

With the appointment of Dr. Hubbard, the Survey entered upon a period of thorough reorganization. It was severed from the Mining School and the University; the efforts of the directors were not henceforth to be divided with other interests; and the Survey was no longer to be an appendage to the University or to the College of Mines, a condition considered by the Board to be beneficial to those institutions, but detrimental to the Survey.

On October 6, 1893, the Board of Control of the Mining School passed a resolution giving the Survey permission to erect a suitable building on the east side of the Michigan Mining School property, and to occupy it rent free as tenants at will of the Board of Control of the Mining School. The offer was accepted, and through the efforts of Dr. Hubbard the citi-

zens of Houghton contributed $1,100, to which the Survey added $1,500. A small building, a story and a half high, equipped with a fire-proof vault, was erected and at last, after an existence of over half a century, the first department of the State to be created received housing of its own.

Up to this time, the history of the achievements of the Third Survey is mainly a record of exploration and progress in the Northern Peninsula, aside from the brief interrupted work of Prof. Winchell, and the lonely work of Dr. Rominger, and some records and statistics collected by Mr. Wright on the salt and gas wells of the Southern Peninsula. But since the United States Geological Survey was at this time completing the *Monograph on the Lake Superior District*, and since further work by the Michigan Survey would lead to duplication, Dr. Hubbard agreed to continue state survey work only on Keweenaw Point and Isle Royale.

Exploration was extended to the Southern Peninsula under direction of Dr. Lane. He had been engaged in making microscopical studies of the thin section of Michigan rocks collected by Mr. Wright, and had carefully worked over the notes and records of gas and salt wells left by Mr. Wright. From these, he prepared the first important contribution since that of Prof. Rominger to the literature of the geology of the Southern Peninsula, *The Geology of the Lower Peninsula with Reference to Deep Borings.*

During the year 1895–1896, Dr. Hubbard was engaged in intensive field study of the copper-bearing rocks, Keweenawan Series on Keweenaw Point, and at the same time Dr. Lane was engaged in making a similar study of the same series of rocks, which compose the unique Isle Royale. Dr. Hubbard made particular studies of the acid intrusives of the lower part of the series and obtained many data, which enabled him to elucidate many valuable details of structure and to interpret results of exploration, particularly near Portage Lake. Dr. Lane's studies of Isle Royale were similar to those of Dr. Hubbard, but included minute studies of the copper-bearing rocks of the island, their origin, composition, structural and topographic

relations, and the geological processes by which they were metamorphosed to their present condition. Dr. Lane reported also on prehistoric copper mining on Isle Royale.

The reports of the two surveys embody the highest type of geological work; they were accompanied by valuable maps and were ready for publication in December, 1896. But they also were fated to delay in printing. For some reason, the Board of Auditors refused publication of Survey reports unless authorized by the Legislature. This caused a delay of two years and resulted in the passing of Act 79 of the Laws of 1899, which authorized the publication of Survey reports. After the passage of this act, the reports were published by Dr. Hubbard's successor, though properly belonging to Dr. Hubbard's administration.

Many inquiries about the economic mineral deposits came to the Survey office from people within and without the State. Since lack of data on the exact location of such deposits was a serious drawback to exploration and development, the Survey planned to accumulate it. Dr. Hubbard laid out a plan which was to determine the geological structure of the Southern Peninsula. His plan was to make accurate examination (by county unit) of several segments of the Michigan Basin, as the geology of any given segment would approximate that of any other; to begin simultaneously on different parts of the formation; to construct maps showing surface and rock contours, and to receive information in regard to the economic aspect.

In the consummation of this plan, field-work was carried on in Huron, Sanilac, and Monroe counties by Dr. Lane, Dr. C. H. Gordon, and Prof. W. H. Sherzer, respectively. The work was begun most auspiciously; the field-work was completed late in 1897 and the manuscript submitted early in 1898, but, because of the refusal by the Board of State Auditors to order printing of plates for the county bulletins, the publications did not reach the people of the State, for whom they were intended. Pending legislation, Dr. Lane addressed a number of farmers' institutes on the subject, *The Best Farm Water Supply.* "This," says Dr. Hubbard, "seemed the best medium available to bring

before the people a part, at least, of the results of the Survey work."

By 1895, the exhaustion of the "inexhaustible supply of pine" threatened the continuance of the salt industry in the Saginaw Valley, unless a cheap fuel could be supplied. This caused a rapid development in the coal areas, and led in 1898 to Dr. Lane's report on the Coal Basin to help development and give the landowners intelligent information about the economical development of their land for coal-mining purposes. To make the report available, it was printed serially in the *Michigan Miner*, although it appeared later in Volume VIII. It may be said here that all these reports were eventually printed, but, since the delay in printing rendered the work of the Survey temporarily useless, Dr. Hubbard declined to continue county surveys on the same scale as those already surveyed. As a result, in the season of 1898 the county survey was carried on only in Tuscola County, where Prof. C. A. Davis worked almost alone.

On June 10, 1899, Dr. Hubbard tendered his resignation. His administration had been most efficient; he had thoroughly reorganized the Survey, perfected for its development a plan which still remains in effect to some extent, surrounded himself with competent assistants, and, although sadly embarrassed by the unaccountable opposition of the Board of Auditors, had secured results of benefit to the State.

In April, 1899, the Board of Geological Survey elected Dr. A. C. Lane state geologist. Dr. Lane had been connected with the Survey during Dr. Wadsworth's administration and was assistant state geologist with Dr. Hubbard. He was thoroughly conversant with the plans of Dr. Hubbard for the development of the Survey and continued to put them into execution.

The main office of the Survey was now transferred to Lansing and Mr. Savicki left in charge of the Houghton office. Hitherto the interests of the Survey had been devoted mainly to the Northern Peninsula and to structural geology, but the numerous requests reaching the state geologist for information on water supplies, coal, clay, etc., brought about, in a measure, the con-

tinuance of investigations of the economic geology of the State, and naturally caused the activities and publications of the Survey to assume a more diverse character.

Field-studies were made of the delta of the St. Clair River and of the gypsum deposits and industry of the State. In the Northern Peninsula, an exploration and reconnaissance along the northern shores of Lake Michigan and Lake Huron marked the beginning of Prof. Russell's active work on the Survey; an examination of the copper-bearing rocks between Bessemer and Lake Superior down to the Black River was made. Dr. Hubbard continued without salary to direct the work of the Survey, but in 1903 found it impossible to devote time to it, and Dr. Frederic W. Wright was appointed assistant state geologist.

Dr. Wright made a study of the Porcupine Mountains and Mt. Bohemia, and towards the close of Dr. Lane's administration, Mr. R. C. Allen began a study of the Iron River district. In addition, Mr. Leverett prepared a report on the surface geology of the peninsula, and Dr. Lane made a study and analysis of the potable waters of northern Michigan and correlated copper drillings from data furnished by the mines.

In the Southern Peninsula, in accord with Dr. Hubbard's plan to secure data on the economic deposits of the State, examinations were made of salt-shafts, peat deposits, the Port Huron oil field, and foundry sands. County investigations were completed in Arenac, continued in Lapeer, Muskegon, Bay, and begun in Wayne. A survey of Alcona County was made at the expense of the County and one of its citizens, Mr. J. H. Killmaster.

The most important contribution, perhaps, to the literature of geology of the Southern Peninsula during Dr. Lane's incumbency is *The Geological Section*, by Dr. Lane and Prof. A. E. Seaman. The section for the Southern Peninsula was made from a careful examination and correlation of well records by Dr. Lane; for the Northern Peninsula, from drill records and personal observations made by Dr. Seaman. The section was published in 1909, a fitting close to Dr. Lane's long and active connection with the Survey.

In securing legislation and appropriations for the Survey, Dr. Lane was not so successful as in obtaining aid in the scientific field. From the amount of work done and the very meagre appropriation ($8,000 a year), one is constrained to believe that much of the work was a "labor of love," perhaps fittingly repaid by the scientific world, but most unsubstantially rewarded by the chief beneficiary, the State of Michigan. Some needed legislation, however, the establishment of the divisions of topographic and biologic surveys, was secured.

In 1901, a contract was signed by C. D. Walcott, director of the United States Geological Survey, and Dr. Lane, state geologist of Michigan, for the execution of a coöperative topographic survey of what is now known as the Ann Arbor Quadrangle. It is interesting to remember at this point that Act 49, 1838, provided for a topographical department, and Act 92, 1844, provided a salary for a state topographer. For the Ann Arbor Quadrangle, $4,000 was to be expended by the Federal Survey and $2,000 appropriated from the meagre general fund of the State Survey. The total was not sufficient to complete the mapping and it was finished at Federal expense.

The satisfactory completion of this map, the demonstrated value of the Menominee sheets (prepared by the Federal Survey), and the repeated endorsements, earnest solicitations, and indefatigable efforts of scientists, scientific societies, and the state geologist, convinced the Legislature of 1903 of the need of such topographic work, and it devoted, therefore, the sum of $1,000 to continue the work. This act was a step in the right direction, but it did not go far enough. The Legislature of 1905, however, by Act 251, authorized the Board of Geological Survey to accept the coöperation of the United States Geological Survey "in the preparation and completion of a contour topographic map of this State, which is hereby authorized to be made." The division has since grown, but during Dr. Lane's administration the Legislature did not see fit to appropriate sufficient funds to carry the work to speedy completion, although the Federal Survey was willing to coöperate.

The original acts creating the Survey included also provi-

sion for a biological survey, but with the reorganization of the Survey in 1869, the Legislature made no provision for carrying on the biologic work. As a result, for thirty-six years an important field was neglected. The Academy of Science attempted to remedy the matter. From the year 1900, brief references are made in the Board of Geological Survey to the attempts to reëstablish the biological division. Dr. Lane asked for an appropriation of $1,000 "till we can see what the work needs." In 1903, the Board asked Dr. Lane to confer with the biological departments of the Agricultural College and of the University and to submit a plan for the conduct of the survey. The result of these activities was the passing by the Legislature of 1905 of Act 250, which authorized "a thorough biological survey of the State" under the direction of the state geologist.[2]

The Biological Survey did not lack material for early publications. Ecological studies had been made during 1904 and 1905 in the Porcupine Mountains and Isle Royale. These expeditions had been made at no expense to the State, but had been made possible through the generosity of public-spirited friends of the University Museum, Mr. H. M. Kauffman, Hon. Peter White, and Dr. Bryant Walker.

The prolonged strike of the hard-coal miners in 1902–1903, followed by the scarcity and general high prices of all sorts of fuel, led to consideration of all possible sources of fuel-supply, among them, peat, since about one-seventh of the area of Michigan was estimated to be swamp-land. Dr. Lane prepared a brief report on peat in 1902, and later assigned to Prof. Davis the task of making an extended investigation of peat formations, deposits, and distribution in the State. The resulting report is a classic. The demands for it, resulting in the speedy exhaustion of the edition, and the continued requests, alone prove the wisdom, if proof is needed, of establishing the Biological Survey.

A biologic survey, mainly in the interests of the Fish Commission, was made of Walnut Lake, Oakland County, to de-

[2] This is the first law since that of 1869 in which the words "State Geologist" appear.

termine why whitefish thrive in this particular lake, though unable to maintain themselves elsewhere. Other investigations were well under way for later reports.

An outcome of the organization of the Biological Survey was the forming of an advisory committee for the Survey, an extra-legal body of scientific men known as the Board of Advisers, consisting of two geologists, two botanists, and two zoölogists. In 1908, Dr. A. G. Ruthven, of the University of Michigan, was appointed chief naturalist of the Survey.

In 1909, Dr. Lane resigned from the Survey to accept a position in Tufts College, after an association with the Survey of more than twenty years. During this time he had watched the Survey grow from a small department adjunct to the College of Mines, employing part time of a geologist and functioning mainly in the Northern Peninsula, to an independent organization employing a large body of trained scientists, although always sadly hampered by insufficient appropriation.

In September, 1909, Dr. Lane was succeeded by Mr. R. C. Allen. The work of the past eleven years is too well known to justify detailed discussion here, but, in view of the slow growth of the Survey since 1837, the growth of the past decade has been almost phenomenal. The Survey has expanded to include the departments of geology, topography, biology, mineral resources and mines appraisal. It coöperates with the Federal Survey in topographic work and collection of mineral statistics, and also with practically every department of the State government, particularly the Securities Commission, Tax Commission, Highway Department, Public Domain, Department of Health, State Park Commission, Agricultural College. It coöperated, too, with the Ohio Survey in the re-location and marking of the Ohio-Michigan boundary line. Twenty-nine publications have been issued, including eight bulletins on the mineral resources of the State, five biological reports, eight geological studies, two reports on economic geology, three on surface geology and one on drainage. These publications show the diversity of activities directed by the Survey, and their wide extension over the entire State.

Various laws have been passed relating to the Survey. Act 7, 1911, abolished the office of commissioner of Mineral Statistics and transferred his duties to the Board of Geological Survey; Act 341, 1913, created definite connection with the Tax Commission by making an appropriation for the purpose of mines appraisal; Act 373, 1917, authorized the making of a soil survey of the State. Emphasizing again part of the enabling act of 1869, the last act authorized and directed the Survey "to investigate soils and subsoils in their relation to agriculture, and to publish and disseminate this information among the people."

The purpose of the law was approved by Governor Sleeper as witnessed by his signature to the act, but as chairman of the Board of Geological Survey he refused to permit the work to be done.

In October, 1917, the Board of Geological Survey authorized coöperation with the United States Department of Agriculture in a drainage investigation of the State. Every county was investigated by an engineer representative of Drainage Investigation. Conferences were held with each county drain-commissioner; drain records were examined and abstracted and compiled; county officials interviewed; field-trips made and drains investigated. The report was published for the Legislature of 1919, but although a bill to remedy drainage was introduced, the Legislature adjourned without passing the much-needed law.

Much larger appropriations have been secured and wisely expended. In fact, since 1869, the various legislatures have appropriated somewhat more than a half-million dollars for the geological, mineralogical, biological, and topographical survey of the State, of which about half has been appropriated and expended since 1909. It should be noted that a large part of the recent appropriations has been made for the work with the Tax Commission, and the appropriations have been more than justified by the increases added to the State income from taxes through that coöperation.[3]

[3] During the existence of the Survey, the total appropriations and expenditures have been as follows: total appropriations, 1869–1920,

The Great War did not find the Survey unprepared. Coöperation was given in mapping the Custer area. In the Survey records, the War Minerals Committee of the Council of National Defense found, without special investigation, an adequate source of information concerning those minerals needed, particularly a sand for optical glass. Two members of the staff of 1917 enlisted and saw service overseas, and the director served in Washington as a member of the Board of Tax Reviewers.

After the Armistice, the Survey prepared to go back to more intensive work in the economic field. Upon the return of the staff engaged in active war work and military operations, the routine work of the war period gave way to more precise geological investigations and to plans for expansion. Topographic mapping was renewed so that now about twenty per cent of the State has been covered.

As a result of increased need for competent geologists in post-war reconstruction of the industries of the country, Mr. Allen was made numerous flattering offers by mining interests. In October, 1919, he resigned as state geologist to accept the vice-presidency and general managership of the Lake Superior Iron Ore Association.

On October 28, 1919, the Board of Geological Survey appointed Mr. Richard A. Smith to the office of state geologist, director of the Geological Survey.

In brief review, the Third Survey, organized by law in 1869 to make a mineralogical and geological survey of the State, has been expanded by various acts of the Legislature until now it consists of three main departments: geological, with the divisions of Geology, Appraisals and Mineral Statistics; topographical; and biological. The Survey is housed in offices on the fourth floor of the Capital National Bank Building. It has investigated and is investigating the geology, physiography, drainage, topography, economic resources in metals and nonmetals, fauna and flora of the State as well as assisting other de-

$556,935.60; total expenditures, $508,077.59; total appropriations, 1909–1920, including the present appropriation, $250,727.59; total expenditures after 1909, not including the fiscal year of 1920, $199,534.23.

partments of the state government, particularly in the appraisal of mines for taxation purposes. "The Survey as now organized occupies a unique position among the similar organizations of other states, because it has led the way in adapting the results of its scientific investigations, as well as the technical ability of its staff, to the practical needs of the State, not only in the development, use, and conservation of our natural resources, but also in the direct administration of some of the important laws. The Board and its staff have seized on every opportunity for useful service, so far as the facilities and funds have permitted."

It has not been possible in this sketch of the history of the Survey to review the work of all the geologists and their assistants, and it has been necessary to neglect entirely the work of many others who have directly or indirectly furthered the work of the Survey. To enumerate them all would be to recall the names of geologists, mineralogists, biologists, topographers, and others connected with the various educational institutions of this and other states, and with the Federal Survey, whose studies have enriched the literature and contributed to the present fund of knowledge of the geology and natural history of Michigan, as well as those private individuals whose generosity and interest in scientific pursuits have made many of the studies possible. All have believed in and sought to make the world see the truth of the motto on the state coat of arms: *Si quaeris peninsulam amoenam, circumspice.*"

State Geological Survey
Lansing, Michigan

A NEW GASTROPOD AND A NEW CEPHALOPOD FROM THE DEVONIAN OF MICHIGAN

G. M. EHLERS AND R. C. HUSSEY

INTRODUCTION

An excellent collection of fossils from the Devonian rocks of Alpena and Presque Isle counties, Michigan, was recently presented to the Museum of Geology of the University of Michigan through the generosity of Mr. H. H. Hindshaw. In this collection were found the types of the new species described in this paper. When further examined, it will undoubtedly yield other new and interesting fossils.

DESCRIPTION OF SPECIES

PLEUROTOMARIA (?) ALPENENSIS N. SP.

(Plate XXXVII, Figures 1, 2 and 3)

The only known specimen of this species, which is provisionally referred to the genus *Pleurotomaria*, is poorly preserved; the apertural part of the shell and most of the spire have been destroyed. Certain structures of the specimen are, however, very striking and serve to distinguish it from other gastropods.

The uninjured shell was turbinate, the spire was more or less depressed, and the whorls probably numbered about four. The last whorl, which makes up most of the specimen, is transversely subovate in the section near the aperture. The upper and lower surfaces of this whorl are convex; the convexity of the latter surface is somewhat less than that of the former. The periphery is marked by a narrow slit band with elevated margins. The whorl, at least near the aperture, is thinnest on its inner side. This is indicated in part by the fact that this

side easily takes a distinct impression of the lamellose folds or ribs of the lower side of the preceding whorl. The inner lip is considerably thickened and reflexed, nearly or quite covering the umbilicus. The surface of the last whorl below the slit band is ornamented with well-defined, rounded, revolving ridges or spirals; the one in contact with the lower side of the slit band is somewhat larger than the others.

Crossing the spirals are lamellose folds or ribs, which toward the aperture extend outward as broad, foliate expansions, and become more conspicuous than the spirals. All of the ribs extend upward to the top of the slit band; a smaller number extend above it and are traceable to the top of the whorl. The latter, where they cross two somewhat distantly separated spirals on the upper side of the whorl, are bent upwards and backwards, forming prominent nodes or spines with more or less semicircular excavations on their anterior sides. Some of the ribs, at a few places between the two distantly separated spirals, and at points where they cross a narrow spiral occupying a position just above the upper one of these spirals, are raised into very low nodes with crescentic cavities on their anterior sides. Both large and small nodes are of the type of the modern gastropod *Fulgur carica*. The surface of the shell is further ornamented with very fine striae, which are parallel to the ribs.

According to Mr. Hindshaw, the type specimen of this species (No. 1261, Museum of Geology, University of Michigan) was collected from the Alpena limestone member of the Traverse formation at El Cajon Bay, Alpena County, Michigan.

NEPHRITICERAS HINDSHAWI N. SP.

(Plate XXXVII, Figure 4, and Plate XXXVIII)

The only known specimen of this species consists of the left half of a shell, which is preserved in a fragmentary condition. The apical end of the shell is badly crushed and the living chamber flattened.

The shell is large, coiled in one plane and expands rapidly from the apical to the apertural end. In the uninjured state,

it had little more than one volution; the apical end probably was in contact with the dorsal surface of the living chamber near the aperture. At the aperture, the dorso-lateral parts of the shell seem to have extended forward, forming on each side of the shell an auriculate expansion. The contour of the edge of the expansion on the left side is indicated in Plate XXXVIII by a full line, which represents a seemingly uninjured part of the apertural margin and by a broken line, which represents the probable position of the unpreserved part of the margin. The sides of the shell, especially anteriorly, slope rather abruptly toward an umbilical perforation, the width of which is about 26 mm. The cross section of the posterior part of the shell seems to have been more or less subcircular.

The living chamber is very large; its length, measured along the ventral side, is about 168 mm. The camerae increase in depth somewhat regularly from the apical part of the shell to the fifth one posterior to the living chamber. The five camerae behind the living chamber decrease in depth toward the latter; the most anterior one shows a decided decrease in depth with respect to the four immediately behind it.

The septa have an average thickness of about .75 mm. The sutures on the lateral slopes of the shell are nearly straight except for very broad, ill-defined lobes.

The shell is ornamented by very conspicuous, rounded, revolving ridges, which gradually diverge from the apex to the aperture. The tops of these ridges near the posterior, crushed end of the shell are distant from one another about 2 mm., and near the aperture about 10 mm. The ridges on the ventral side of the shell have been brought close together by compression. On the lateral slopes toward the aperture, the ridges become flatter and broader. This seems to be due to solution, and to the flattening to which the anterior part of the shell has been subjected. Well-preserved parts of the outer surface of the shell are ornamented with very fine, transverse striae, which undoubtedly covered the entire surface.

The average thickness of the shell is about 1.75 mm. The shell is about one and one-half times as thick in the revolving

ridges as in the interspaces. A maximum thickness of 3 mm. was noted in the ridges on the lateral slope near the posterior part of the living chamber. Towards the aperture, at least on the lateral slopes, there is a thinning of the shell, which seems to be the result of solution or compression.

The type specimen is of interest in that it shows old age characteristics, such as the auriculate, forward expansions of the shell and the decrease in depth of the camerae behind the living chamber.

This species somewhat resembles *Nephriticeras liratus* (Hall) from the Devonian of New York State, but differs from that species chiefly in having a smaller number of volutions, a less rapid expansion of the shell, and a wider spacing of the septa.

The holotype of this species (No. 7530, Museum of Geology, University of Michigan) was collected by Mr. Hindshaw, in whose honor the species is named, from the Long Lake member of the Traverse formation in Sec. 7, T. 34 N., R. 5 E. (about four miles north of Hawks Post Office).

UNIVERSITY OF MICHIGAN

EXPLANATION OF PLATES XXXVII AND XXXVIII

PLATE XXXVII

Pleurotomaria (?) alpenensis n. sp. (Figures 1–3)

Fig. 1. Lower side, showing spirals, ribs and reflexed inner lip.

Fig. 2. Side view, showing slit band and prominent spines on the upper side of whorl.

Fig. 3. Upper side, showing spines located on two widely separated spirals.

All of these figures are natural size.

Nephriticeras hindshawi n. sp.

Fig. 4. Side view, showing preservation and ornamentation of shell. X 1/2.

PLATE XXXVIII

Nephriticeras hindshawi n. sp.

Side view of specimen with portions of the shell removed, showing sutures, depth of living chamber and camerae, and probable contour of the auriculate forward expansion of the shell. X 1/2.

PLATE XXXVII

FIG. 1

FIG. 2

FIG. 3

Pleutomaria (?) **alpenensis,** N. SP.

FIG. 4

Nephriticeras hindshawi, N. SP.

PLATE XXXVIII

Nephriticeras hindshawi, N. SP.

THE SOUTHWESTERN MICHIGAN METEOR OF NOVEMBER 26, 1919[1]

WILLIAM HERBERT HOBBS

INTRODUCTION

In the early evening of November 26 (Thanksgiving Eve), 1919, a meteor was observed from many points throughout Van Buren, Berrien and Cass counties in extreme southwestern Michigan, and at one or more points in the encircling counties of Allegan, Kalamazoo and St. Joseph in Michigan, and at St. Joseph, Elkhart and Lagrange in Indiana. In addition, it was reported from several more distant points, viz.: near Wewaka in Noble County, Indiana; Albion, Adrian, Saranac (Ionia Co.), Mason (Ingham Co.), Muskegon, Croton (Newaygo Co.), Ludington, and Thompsonville (Benzie Co.), all in the Southern Peninsula of Michigan. From three quite remote points also it was reported; Milwaukee across Lake Michigan, Newberry in the Upper Peninsula of Michigan about fifty miles northwest of the Straits of Mackinac, and at Lucknow in Ontario.

In the *Grand Rapids Press* of November 27 (Thanksgiving Day), a semi-sensational, semi-humorous account of the meteor was published under the head, "METEOR FELL IN LAKE OR THERE WAS QUAKE, AURORA WENT ON SPREE OR—SOMETHIN' HAPPENED." Friday morning, November 28, the *Chicago Tribune*, which circulates within the district in which the meteor was widely reported, carried the head "METEOR THAT ROCKED STATE IN LAKE, BELIEF," and the *New York Times* carried on the front page a Detroit despatch headed, "HUGE METEOR FALLS INTO LAKE MICHIGAN." A statement attributed to the light-

[1] This paper was read also before the American Philosophical Society at the annual meeting in April, 1920.

house attendant at Grand Haven, which appeared in the last two papers, is as follows:

> What looked like a ball of fire appeared to fall in the lake about fifteen miles south of me. I thought it was a falling star. I could hear it whistle during its terrific rush toward the water. When it seemed to strike the water, a flash of flame shot in the air and caused a great disturbance.

This report was copied and carried by many papers of later date, especially by weekly country papers. When the writer first visited the region about a week later, the effect of the impression from reading this account was so general that it was in many cases difficult to secure correct independent reports of what each observer had himself seen. Examination into the original report from Grand Haven, no less than the broader investigation as a whole, soon convinced the writer that the meteor, or at least a portion of the original mass, must have fallen upon the land.

On December 4, the writer sent out a questionnaire addressed to editors of newspapers published in southwestern Michigan and in northwestern Indiana, some forty-five in all, and in addition to superintendents of schools in twenty-six of the larger places of the district. Within a week after the fall of the meteor, he visited points in Van Buren County, and later made trips to other portions of the district. The newspapers gave publicity to the questionnaire, and an extended correspondence developed with eye and ear witnesses throughout the district. Their testimony forms a large part of the basis of this report.

Mr. C. F. Schneider, the very able meteorologist in charge of the Weather Bureau station at Grand Rapids, early took a lively interest in the investigation and independently assembled reports from observers at the Michigan stations of the Weather Bureau. These reports are of great value and have been kindly placed at the writer's disposal. A request for information about the meteor which had been addressed to the Department of Marine at Ottawa by Mr. Alfred Cooper of Beaconsfield, Bucks., England, was by that department referred to the Inspector of

the Twelfth District of the United States Lighthouse Service, and was the starting point of further assembling of data from observers in that service. This valuable information also has been placed at the writer's disposal. Acknowledgments are due especially to Mr. Schneider and to Mr. N. M. Works, the first assistant superintendent in the Office of Inspection of the Lighthouse Service at Milwaukee.

So far as is known, the meteoric stone which fell at Allegan in southwestern Michigan in 1899, is the only other fall of a meteorite which is upon record for the State of Michigan.[2] In addition there are two "finds" on record. These are the Grand Rapids iron of 51.9 kilograms found in September, 1883, in the course of excavations in that city; and that of Reed City, an iron weighing 19.8 kilograms, which was found in September, 1895, on a farm near that place in Osceola County.

THE APPEARANCE OF THE METEOR

Had the evening been clear, the meteor would undoubtedly have been visible over a wide area as a brilliant body having a definite form and leaving behind it a definite train. The weather throughout the region of its near approach to the earth was either cloudy or rainy, so that its appearance took on generally the character of a sudden brilliant illumination, which was described by many as resembling heat-lightning.

It may at first appear strange that the best observations were rather generally made at positions remote from the place of near approach to the earth's surface. This is due to the fact that from these points the object was seen at a great height, and along a line of direction which was above and clear of the low rain-clouds into which it later disappeared. Those rare observers who were nearer, and who also sensed the moving meteor as a "ball of fire," either got fortuitous glimpses

[2] George P. Merrill and H. N. Stokes, *A New Stony Meteorite from Allegan, Michigan, and a New Iron Meteorite from Mart, Texas*, *Proc. Wash. Acad. Sci.*, 2: 41–68, 1900. See also *Bull. 94, U. S. Nat. Mus.*, p. 21, Plate VII.

through a rift in the clouds, or were so near the body when it reached the earth as to see it even through the fog.

After the general area of the probable fall of the meteor had been roughly determined, there occurred a heavy snowfall, so that a suitable opportunity of searching for the body did not arise till the following summer. Such search as has been carried out during two brief trips to this area has served only to make it improbable that it will be found except by mere accident, since a large part of the area is swampy, or wooded, or else has been plowed over. The hope that the body might be found is in part responsible for the long delay in assembling this report.

OBSERVATION OF THE METEOR AS A "BALL OF FIRE"

The following observations of the meteor as a definite form, rather than as an illumination or as a flash of light, were made in Michigan:

Newberry, Luce County

A very brilliant meteor was seen about eight o'clock on the evening before Thanksgiving in a position about southwest when first noticed and considerably above the horizon, though relatively low. Its course was southeastward and downward at a point south by about 9° west near the horizon. It burst like a rocket and sank from view, all in a few seconds. The hands of the observer, A. L. Harter of the Newberry State Hospital, were held about thirty-eight inches apart to show how big it looked. — Reported through Meteorologist Schneider.

Ludington and Point Sable

A brilliant meteor was seen by watchmen at the Coast Guard stations of Ludington and Point Sable at 7:45 P.M. on the twenty-sixth. It was first seen almost overhead, whence it moved to the south, leaving behind a trail of blue. When near the southern horizon, and apparently along the lake shore, it burst like a sky-rocket into many pieces, which were colored blue, red, green and yellow and otherwise, and fell to the ground. A swishing was heard as the meteor passed through the air; no explosion and no shock were felt. — Reported through Meteorologist Schneider.

Thompsonville, Benzie County

Richard Emmons, a thirteen-year-old boy, going home "about 7:45 saw a ball of fire as large around as a stove fall from near the top of the sky and soar southward to the ground. It made the night as light as day." — Report in *Thompsonville News*. To the writer the boy reported that the meteor was seen about 7:45 P.M. and was in view about four seconds. It was colored blue and white. No sound was heard.

Muskegon

Mr. and Mrs. A. W. Gunn, city-editor and society-editor respectively of the *Muskegon Chronicle*, with their daughter, Mrs. W. V. Johnson, of Traverse City, were on the street facing south with a clear view of the sky. "They state that the entire sky was at first lighted with a brilliant blue light. Then through a small rift in the clouds they witnessed the meteor. . . . The larger meteor appeared to be as large as the moon. The second part, which closely followed and apparently in the same path, was much smaller. The occurrence was at about 7:45 P.M." — *Grand Rapids Press* and *Muskegon Chronicle*. The meteor was also reported as appearing to strike south of the city, but no explosive sounds were heard.

Grand Haven

"E. B. Wright, coast-guard, states that the meteor was travelling due south, passing directly over his station, and that it apparently fell upon land on or near Rosy Mount (a great sand-dune near the lake shore), about four miles south of his post of duty. As it passed above him, he was in position to ascertain the direction with considerable accuracy. The principal luminous center resembled the moon and was closely followed by a smaller one. The flash lasted probably ten seconds and no sound was heard. The light was of a bluish-white. There remained a long streak somewhat like the tail of a comet for about fifteen seconds after the meteor had disappeared." — Keeper's report to the Lighthouse Service supplied by Supt. Works.

Mr. W. E. Dodge, radio operator at this place, reported a meteor "with two centers, first like the moon, second smaller."

All the observations recorded above were made at points distant from the region of rather general observation within which the meteor was described as a bright illumination and as accompanied by various sounds. They are rather consistent in their indication that the direction of the meteor was to the

southward of the observer, and that no accompanying sounds were heard. They are also generally consistent in describing the direction of movement of the body to be from some point above the horizon downward toward the horizon.

Observations made within the region of near approach to the earth's surface are equally consistent in showing that the movement of the meteor was from the southeast toward the northwest. This apparent discrepancy is susceptible of simple explanation. The remote observers to the northward, all of whom saw the meteor as a definite object, were under a clear sky, and the meteor was observed as it entered the atmosphere at a great height. Even though the object had been approaching them, if it came to earth far to the southward, it would give the effect of a body moving in the opposite direction, or toward the southern horizon. As a consequence of the clouds, fog, and rain which generally prevailed, only the illumination was seen, except in the case of the very few persons who happened to be very near to the meteor when it came to earth.

I am indebted to Professor C. F. Schneider for the meteorological data which appear upon Map II (See page 259), and which apply to the hour of 8 P.M. on November 26, within a quarter of an hour of the time of the meteor's fall.

The persons who observed the meteor at Muskegon stated positively that the object was seen through a rift in the clouds. This locality is obviously near the boundary of the clear sky. Ludington reported that low down in the sky near the horizon the meteor burst like a rocket. As we are to see, both the light and the sound observations within the district of near approach to the earth afford confirmation of this view.

The observations which follow differ notably from those outlined above, and they are believed to indicate that the observers were relatively near to the place above which the meteor broke up and fell:

Four Miles S. S. W. from Dowagiac

Mr. L. L. Hamilton, undertaker at Decatur, while driving in a Ford car on the east road from Dowagiac to Niles, observed the meteor

Map II. Light Phenomena observed in connection with Fall of the Meteor of Southwestern Michigan on the Evening of November 26, 1919.

The sky and weather indications are of 8 P.M.

when he was going west on Townline Road near the house of Charles Stretch.

"I was frightened by a white light touched with green and by flashes that were at least ten or fifteen seconds displayed. A big ball of fire which looked as big as a balloon disappeared in the woods in front of me. When this occurred, I at first let go of my steering wheel, pulled up on my clutch, and stopped. It seemed as though I was stunned and could not stir. I did not hear a very loud sound — only a jar — as my engine was running. I regained my senses, the light disappeared, and I resumed my journey. I could not see anything in the woods, but noticed an odor like sulphur burning. When I arrived at the house of a friend two miles this side of Niles and reported to them what I had seen, I learned that they had seen the same light, though not so intense and bright. This happened about eight o'clock. I should judge that the body took a plunge into these big woods. It came from the southwest going northwest. All was lighted up like day in the direction of the woods for a few seconds,. and feeling sure my machine was on fire, I made an attempt to get out and see. By the time I had regained my senses and gotten one foot on the running board, it was all dark except for the light of my machine ahead. Of course, what I saw was through the glass toward the open facing these woods. The movement of this huge fire ball was very slow; it seemed to explode, and leave a fiery tail behind."

Mr. Charles Stretch, near whose house this happened, was interviewed by the writer. He had been at the time in the house, and had seen the meteor, which appeared to him as a flash, but the sound followed immediately. Other reports from persons within houses nearby given to the writer, were likewise that the sound here followed immediately after the flash.

On Dixie Highway, Three Miles South of Dowagiac

Mrs. Hiler, who lives on the Dixie Highway at this point, reported to the writer that she was in her house at a window facing south and saw the meteor as a definite body in a direction a little west of south (this direction I confirmed with compass from her indications). The meteor was observed very low down near the horizon, at a point where are the woods in which Mr. Hamilton reported seeing the meteor fall, though from nearly the opposite direction. Mrs. Hiler reports that the meteor appeared to burst and go to pieces "like a rocket," and that a rumble was heard "almost immediately afterward."

Athens, Calhoun County

William Hutchins at about 7:30 P.M. saw what he described as a bright-red round object like a shooting star, but the size of a common

tea kettle, "move over him going from east to west at an angle of about 45° or less above the horizon. A streak of fire followed it."

APPEARANCE OF THE METEOR AS A FLASH OR ILLUMINATION

Such observations were very general throughout the region of southwestern Michigan and the adjoining parts of Indiana. The points at which the flash has been reported are entered upon Map III (See page 262).

A few of the more interesting observations selected from among many are given below. Since the place of fall is believed to have been near the post-office of Pokagon, the location of these points is sometimes indicated with reference to that locality.

Centerville, St. Joseph County

"Very bright-yellowish light suffused the clouds and seemingly every particle of the cold, misty rain that was falling. The road, trees, houses, and even ourselves were bathed in a blinding phosphorescent-like glow which had its center in a bright streak in the sky above us. It passed over us toward the west. Immediately came a muffled report or jar that shook houses and the very earth like an earthquake." — Statement of Leroy Milhan, highway construction superintendent.

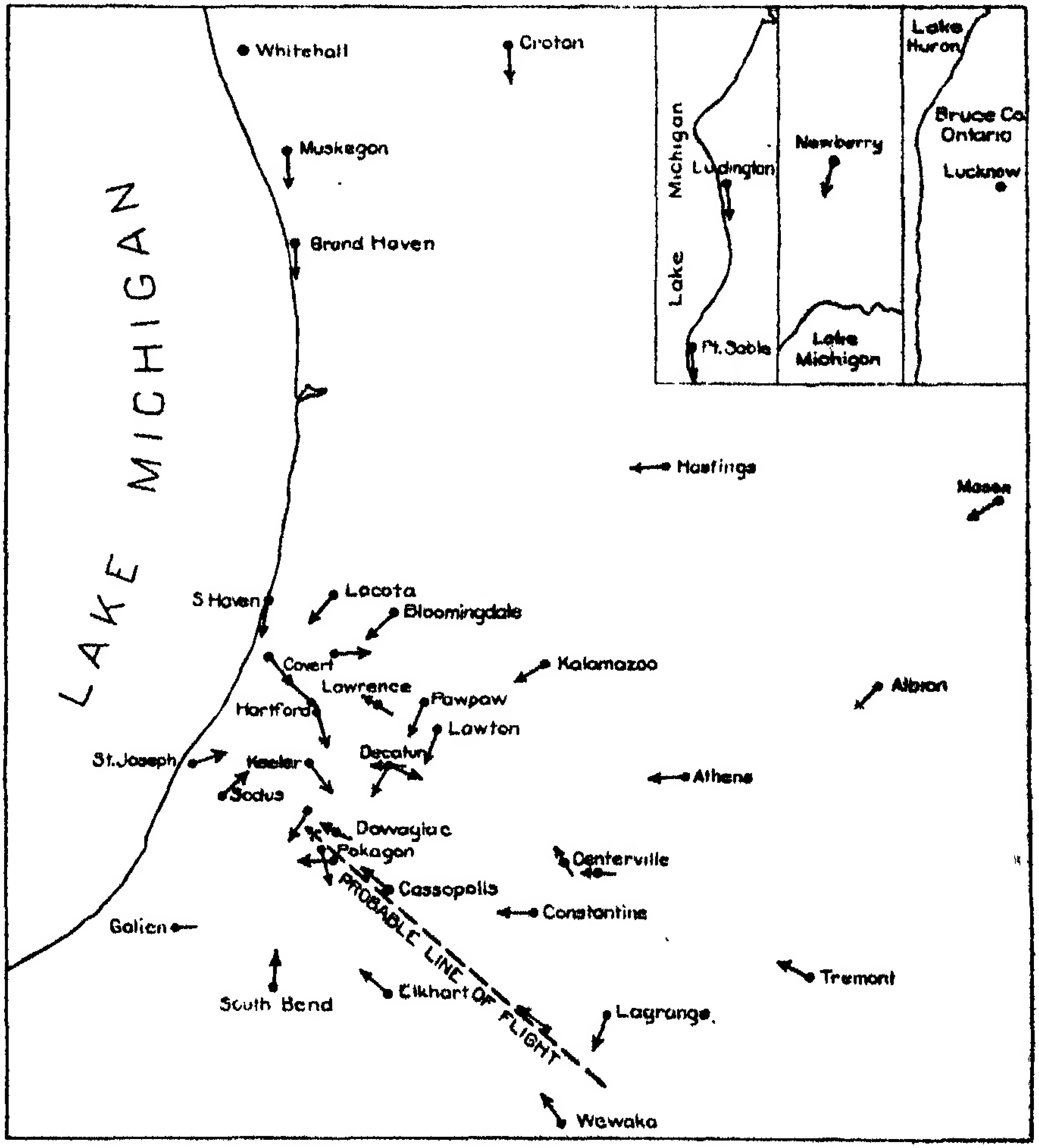
Lawrence, Van Buren County

Lawrence is about 18 miles northwest of Pokagon. A farmer and his wife, who were in the field looking after cattle at a point one mile east and one mile south of the village, report as follows:

"It was very dark and all at once the heavens and the horizon were lighted up, and everything was a shimmering green for a period of two minutes or more. I turned, I recall, and looked at the neighbors' houses in the distance by this light; and then suddenly the green light turned to red and stayed red for at least a minute. The green and red lights were not blended — the green was distinctly green and the red was red."

Notre Dame, Indiana

Notre Dame is just over the state line and about fifteen miles south-southwest of Pokagon. The dean of Notre Dame University reported on the basis of observations by students who were on the campus, that there were two distinct flashes seen to the northward and that these were one or two seconds apart. C. A. McAllister reported



Map III. Sketch Map showing Places Where the Meteor was observed near its Place of Fall.

Arrows transecting the points indicate observed directions of flight. Arrows going out from the points show the direction from the observer in which the phenomenon was seen.

through him that the first flash was green and the second orange-red. Others said that the light was very bright and like that from an electric battery.

Three Oaks, Berrien County

At this point the flash as observed by Mr. Savage was greenish-blue, and afterward the western sky was lighted up with a red glow.

Since the color effects were a very striking feature of the phenomenon, and since observations made at widely separated localities show a considerable measure of consistency, it has been thought best to incorporate here a summary of observations reported from different localities:

Athens. — (a) Reddish (Hutchins); (b) bluish, like electric spark (McMillan).
Bangor. — Bright red.
Cassopolis. — Light, followed by red.
Decatur. — Greenish, turning to light red.
Elkhart (Ind.). — Blue flash.
Grand Haven. — (a) Bluish-white (Wright); (b) bluish-white at first, after which the clouds were suffused with red (Dodge); (c) reddish glow (McConger).
Grand Rapids. — Bluish-green, about color of northern lights.
Hartford. — (a) First greenish-yellow, then different colors (Olds); (b) tint of blue, might have been green (C. A. Boss); (c) greenish-blue (first in south), then rose color to northward and extending only half way to the zenith (Finley).
Kalamazoo. — (a) Deep pink in northwest at first, then spread all around (Robinson); (b) first dazzling white, changing to orange and blue (Browne).
Lagrange (Ind). — Red.
Lawrence. — Everything a shimmering green for two minutes or more, then suddenly the green light turned to red and stayed red for at least a minute.
Muskegon. — Brilliant bluish light at first.
Pokagon. — Very bright white, and blue and tint of yellow.
South Haven. — White.
Three Oaks. — (a) Such light as is made by an electric wire burning out (Fox); (b) flash greenish-blue and afterward western sky was lighted up with red glow (Savage).

IMPRESSION OF THE CONCUSSION

The following variations of the impression received of the shock have a collective value:

Athens. — Jar like heavy thunderclap.
Allegan. — Faint jar.
Centerville. — Jar which shook houses.
Covert. — As though something had struck roof, it jarred the house.
Elkhart (Ind). — Shook house.
Lawrence. — Jarred window-sills and doors.
Pokagon. — Jarred Ford car with engine running.

INTERVAL BETWEEN FLASH AND FOLLOWING SOUNDS AS A MEASURE OF REMOTENESS FROM OBSERVER

Except in the vicinity of Pokagon, near where it is believed the meteor broke up, a distinct interval measured in considerable fractions of a minute or several minutes was observed to separate the time of the flash from that of the following sounds. In most cases the values given are rough estimates only. In several instances, however, observers had the good sense when the sound was heard, after walking a certain distance since observing the flash, to retrace their steps watch in hand, and so fix the interval with considerable accuracy.

It is noticeable that there is an increase in the length of the interval, in proportion as the observing points are distant from the neighborhood of Pokagon, toward which other indications point as the place of fall. At Pokagon Post Office, on the Dixie Highway, north of this point, and at Summerville about one and a half miles west of Pokagon, the sound resembling thunder is reported to have followed close after the flash. At Dowagiac a man was on the street and saw the flash come almost exactly from the southeast. The sound resembling thunder followed after he had walked a block — probably about a minute.

Near Indian Lake, a little over five miles west of Dowagiac, people living at "Gilbert Castle" noticed the flash from within

the house, and after a "two-minute interval" heard the sound. North of this point to Sister Lakes, Sutherland and Forest Home, practically the same report was received throughout, and the close correspondence produced the impression that this interval had been rather generally adopted for the district as a result of discussion, perhaps at the corner grocery. At Berrien Center, about five miles west of Pokagon, the flash was generally reported, but no sounds were heard. At Fairland, about the same distance west-southwest, neither the flash nor sounds appear to have been noted.

At Galien, about fifteen miles west-southwest of Pokagon, the time between the flash and the rumbling sound was estimated at one and a half minutes. At Notre Dame, just over the state line in Indiana and about the same distance away, the estimate of this interval was "slightly more than minute."

At Three Oaks, twenty miles southwest of Pokagon, a man and his wife were walking toward their home. Through Mr. G. R. Fox, director of the Chamberlain Memorial Museum, they report that the flash was seen when they were on the street. They then walked a distance of three blocks to their home and were just entering when they heard a noise like distant thunder. This interval they estimate at three minutes.

At Decatur, about fifteen miles north-northeast of Pokagon, Mr. Brigham, while walking on the street, accompanied by his wife, saw the flash. After continuing a certain distance, he heard the rumble, and after another interval a sound resembling an explosion, which appeared to come from the south. They retraced their steps, watch in hand, and determined that the first sound arrived about forty seconds behind the flash, and the explosive sound ninety seconds after the rumbling.

From Hartford, about twenty miles due north of Pokagon, we have especially valuable data secured by Mr. C. A. Boss, the school superintendent. He noticed the flash and walked a distance which he twice checked by walking at as nearly the same speed as possible. The average time derived for the interval is two minutes and fifty seconds, with a probable error of only five seconds. The direction of the sound appeared to be

south, possibly 20° or 25° east of that direction. There were "two distinct booms like the reports from a heavy gun, close together, but perfectly distinct, not blurred." Two sounds close together were generally reported from Hartford and its vicinity.

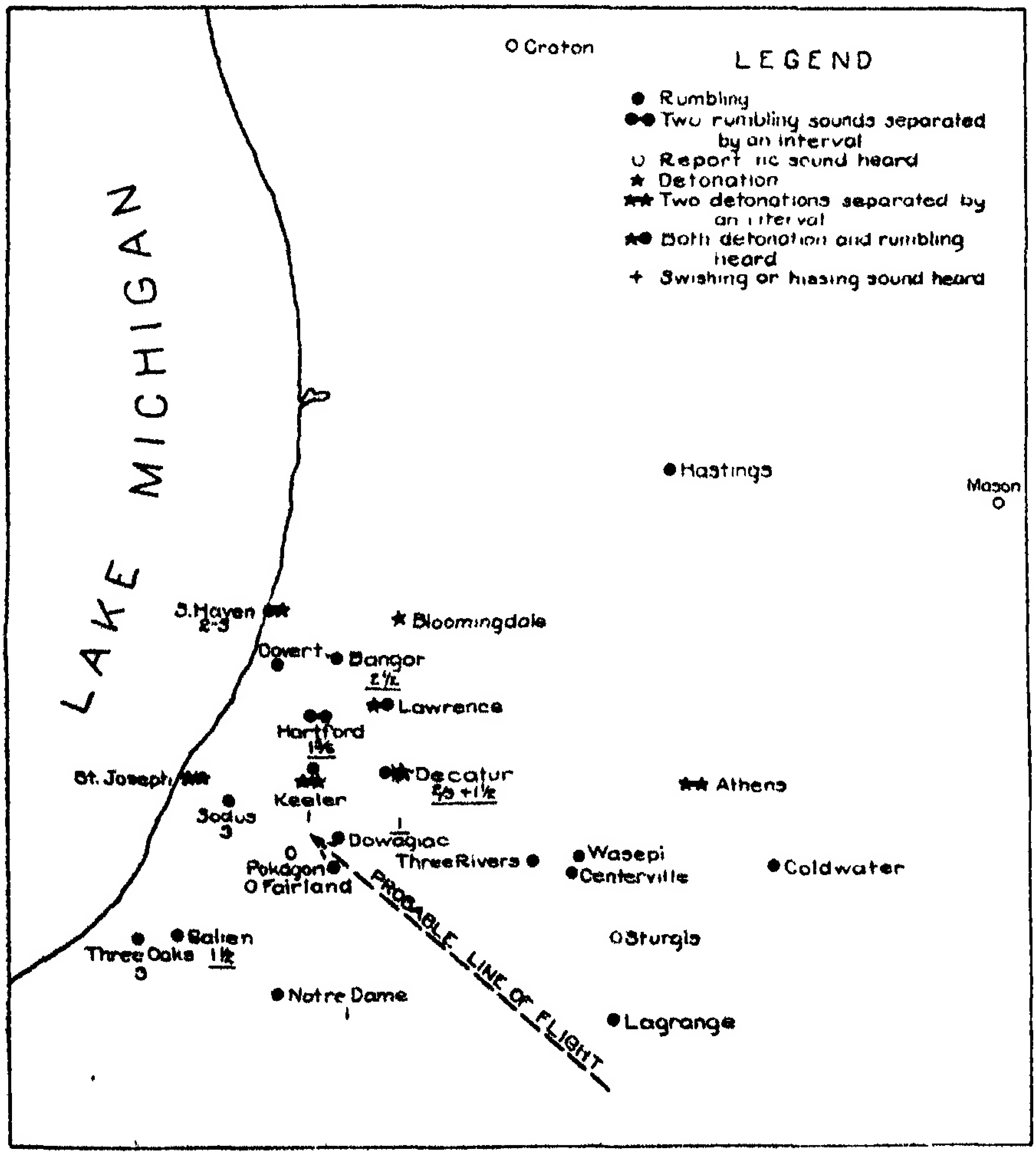
Near Keeler, about twelve miles north of Pokagon and five miles south of Hartford, a truck-driver with a gang of five men was halted with his truck stuck in the mud. All observed the meteor flash as a very striking phenomenon, and the estimate which they give for the place of fall is "two minutes away and a little to the east of south." Two detonations were heard and also "a hissing like a fuse burning."

At South Haven, some thirty-five miles north of Pokagon, Theron Kenneda, a coast-guard of the local station, saw the flash and a minute and a half later, according to his estimate, heard the rumble. Another observer at this place estimated the interval at from two to three minutes. It is quite evident that unless the estimate has been checked by some method, as by the time required to walk a certain distance, it does not have great value. For this reason, on Map IV we have underlined those estimates which have been checked in this manner.

At Bangor, about twenty-five miles north of Pokogan, a valuable estimate was made and checked in the following manner. A gentleman was on a train approaching the station from the north. When the train was on the trestle about a thousand feet from the station, the flash was noticed. He rose from his seat in the parlor car, walked through the short train, and as he was descending the steps of the station heard the rumble. Upon this basis, the estimate of the interval was two and a half minutes.

THE NATURE OF THE SOUNDS

The sounds which were described as accompanying the fall of the meteor were of three general types, namely: (*a*), rumbling, described generally as resembling thunder and explainable upon the same basis, the closing of the vacuum behind the moving body; (*b*) detonations, generally described as explosions



MAP IV. Sketch Map showing the Nature and the Distribution of the Reported Sounds in connection with the Meteor.

The figures in connection with certain localities record the estimate of the time interval between observation of the flash and the succeeding sounds. Those underlined are based upon distance walked during the interval, and they have a correspondingly increased value.

or as the report from a big gun, dynamite, etc., and explainable as the result of the bursting of the meteor from pressure upon its forward surface, aided by the strains set up between the highly heated front and the cold interior; (*c*) whistling, described as hissing, sizzling, burning of fuse, escaping steam, etc., believed to be due to the rapid projection of meteor fragments after the break-up of the body.

The area within which sounds were heard, and the nature of the sounds perceived at each place, have been entered upon Map IV (See page 267). The hissing sound was reported from Decatur, Keeler, and St. Joseph, all in front of the supposed place of break-up near Pokagon. At Keeler and St. Joseph, two distinct detonations were made out. At Decatur, while but one detonation was perceived, it is interesting to note that this occurred ninety seconds after the rumbling. It is also worthy of note that the sounds were generally perceived for greater distances north and west of the supposed place of fall than in the other quadrants, particularly the south and west.

UNIVERSITY OF MICHIGAN

OIL DEVELOPMENT IN MICHIGAN AND THE ANTICLINE AT SEUL CHOIX POINT

R. A. SMITH

The recent oil "strike" near Deerfield in Monroe County has caused a wave of interest in the oil and gas possibilities of Michigan. Inquiries are coming to the Geological Survey not only from every part of the State, but from nearly every part of the country. According to reports, exploration companies are being organized at Blissfield, Lenawee County, and at Shasburg and Dundee, Monroe County. The Deerfield Oil and Gas Company is already beginning its second test, and exploration projects are being considered in several other places in the State.

This summer promises to be the greatest period of "wildcat" exploration that Michigan has ever experienced. Oil at four to six dollars gives alluring possibilities to the numerous small oil wells drilled at Port Huron, Saginaw, Allegan, and in Monroe County in the days of fifty-cent oil, and also to the many showings of oil encountered in many other tests. Several wells at Saginaw and Allegan yielded from one to five barrels of oil, but with oil selling at fifty or sixty cents, profitable operation was out of question. Small wells have been pumped at Port Huron for many years, but it was due to their very shallow depth that they could be operated at all.

With oil selling from five to ten times the price in 1912, small wells are no longer looked at with contempt by the oil producers. The big oil companies are systematically drilling up their "lean" oil territory formerly not considered worth development. In Pennsylvania, old properties are being redrilled on the expectation of an average yield of only a barrel a day, and many of these old properties are being profitably operated where the average daily production is only a few gallons of oil.

There are several localities in the State where conditions appear to offer possibilities. At Port Huron, there is a well-defined fold or anticline only partly tested. The depth to the oil formation is only about 600 feet. The structure, coupled with the fact that there are already over thirty small oil wells in this field, invites further exploration.

In Monroe and Wayne counties, the rock strata are warped, and since the "Trenton" formation is known to contain a number of oil-producing "sands," the southern part of the State offers definite oil possibilities in a number of places.

A fold or a structural bench is indicated at Saginaw. Some oil was struck on this structure and further exploration to the north might result in the discovery of much larger quantities. Two or three wells at Allegan produced from one to five barrels of oil at a depth of less than 1,300 feet. There is an anticline near Niles. The Trenton, in the southwestern part of the State, is not excessively deep. The Niles anticline appears to be the most favorable place for exploration, particularly since showings of oil have been found in some of the formations above the Trenton. A marked anticline fold occurs on Stony Island, Detroit River.

Another one appears to lie in the vicinity of Wyandotte. A broad, indefinite fold lies between Algonac, New Baltimore and Mt. Clemens. Discordant dips of the rock strata are present in Monroe County and a broad, low anticlinal fold lies between Pontiac and Adrian. In the extreme southeastern part of Michigan, the "Trenton" limestone is only about 1,600 feet in depth. The depth increases to the northwest, but the Trenton is accessible in a considerable part of the region along the southeastern portion of the State.

An apparently pronounced anticline occurs in Seul Choix Point, but no detailed field work has been done to determine its extent or importance. The Trenton is at relatively shallow depths along the northern shore of Lake Huron and Lake Michigan, in most places being less than 1,500 feet in depth. At Seul Choix Point, it is probably less than 1,200 feet to the Trenton. This formation is known to contain oil in small amounts, and

possibly exploration along the northern shore of Lake Michigan and Lake Huron might result in the discovery of commercial pools.

The Seul Choix Point, Schoolcraft County, projects southeastward into Lake Michigan for about three miles. Apparently, it owes its existence to an upward folding of the rock strata. The direction of the fold is northwest-southeast in line with the general direction of the Point. It plunges to the southeast at a low angle.

Massive beds of the Guelph (Racine) dolomites lie upon the southeast and the northwest sides or limbs of the folds, and the more thinly bedded Manistique dolomites being exposed along the crest. The dip of the Guelph beds is about 6° or 7° on the south limb and somewhat less on the north limb. The dip of the Manistique beds is much less, ranging from 1° to 5°. The interior of the Point is thickly wooded and the rock is concealed nearly everywhere; hence the extent of the structure to the northwest is unknown and probably can be determined only by the drill.

The Seul Choix anticline appears to be of sufficient size and height to influence the accumulation of oil in underlying formations. There is a possibility that the structure is due to deposition of the beds about coral islands in Niagaran seas. In such case the anticlinal dips observed in the Niagaran strata do not extend to beds lying deeper. The evidence is not conclusive and the conditions cannot be definitely determined in advance of the drill. The relatively steep dips and the character of the Guelph beds, however, indicate that folding has occurred to a greater or less degree, and that the structure is in part a true anticline.

The Niagaran limestone group on Seul Choix Point is probably from 600 to 700 feet thick. No wells have completely penetrated the formation in this region and the thickness can be only approximated from field observations; hence the thickness may be somewhat less than the minimum, or even greater than the maximum.

A heavy series of shales and shale-like limestone underlies

the Niagaran limestones and overlies the Trenton limestone. The latter is a producer of oil and gas in Ohio, and is known to contain oil in small quantities in both the Southern and Northern peninsulas. Near Deerfield, Monroe County, oil has been struck recently in apparently commercial quantities. It is possible, if not probable, that oil may be found in the Northern Peninsula and structural conditions indicate that the immediate vicinity of Seul Choix Point would be a favorable place for testing out the oil possibilities. The depth to the Trenton is relatively shallow. On the extremity of the Point it is probably not much greater than 1,200 feet and may be considerably less. To the northwest, the depth should gradually decrease.

Most of the State, however, is wholly "wildcat," and the risks incident to "wildcat" exploration, especially in Michigan, appear to be very high. This is a point which every prospective investor in "wildcat" enterprises should hold firmly in mind. Geological considerations indicate that, while Michigan may never become a great oil-producing state, scattered pools of oil will probably be discovered.

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MENTAL AGE AND SCHOOL PROGRESS

HARRY J. BAKER

The problem of "over-ageness" in the schools has been with us from the earliest days, and was forcibly brought to our attention by Ayres some twelve years ago. It is interesting to note that modern methods of measuring intelligence were in the making about the same time, although the two problems were not at that time known to be so intimately related. Strenuous measures, involving trial promotions, late entrance, and remedy of physical defects, have solved the problem but slightly and over-ageness is still with us.

The study of retardation in 225 towns and cities in Michigan by Dr. Berry found a total of 24 per cent retarded, of whom 3.5 per cent were retarded three years or more. The age-grade census of Detroit last September showed approximately 4 per cent retarded three years or more. It is with certain of these pupils that this study is concerned. Only the pupils who were given the Binet intelligence examination in the month of December, 1920, will be considered. Of these, 350 cases ranged in school placement from the kindergarten to the eleventh grade, and varied in age from 5 to 18 years.

In Table I (See page 274) is shown the location of these pupils by half-grades and by age intervals of six months. If we accept tentatively the narrow range of normal placement of eighteen months shown between the two parallel lines, 47 pupils fall in that range, 1 is accelerated and 302 are retarded. If we were to draw our line of over-ageness to include only those three or more years retarded, we should still include 101 cases. All of these pupils were referred to the Psychological Clinic by the schools because of their inability to proceed normally with the regular school work. If we were to judge informally upon the basis of chronological age alone, we would expect pupils who are two or three years above grade age and repeating the work

TABLE I.—CHRONOLOGICAL AGE AND SCHOOL PROGRESS

Chronological Age	School Progress																					
	Kg	B1	A1	B2	A2	B3	A3	B4	A4	B5	A5	B6	A6	B7	A7	B8	A8	B9	A9	B10	B11	T
5-6 to 5-11		1																				1
6-0 " 6-5		2																				2
6-6 " 6-11		1	3																			4
7-0 " 7-5		3	2																			5
7-6 " 7-11	2	4	3	2																		11
8-0 " 8-5		2	3	3	2	1																11
8-6 " 8-11		2	3	6	3	3																17
9-0 " 9-5			5	6	4	1	1	1														18
9-6 " 9-11			2	2	3		1		1													9
10-0 " 10-5			1	1	5	6	3	2	3													21
10-6 " 10-11	1			4		2	2	3	1													13
11-0 " 11-5				2		1		3														6
11-6 " 11-11				2		2	2	2		1		1										10
12-0 " 12-5	1			1		2		4	3	3	4	1										19
12-6 " 12-11		1		1			2	1	2	3	4	3	2									19
13-0 " 13-5					1	2		5	4	5	3	2	1									23
13-6 " 13-11					1	2	1	3	1	6	4	5	2	1								26
14-0 " 14-5		1				1	1	3		3	4	3	1			1						18
14-6 " 14-11					1	1	1	2		5	4	8	3	4	2	2						33
15-0 " 15-5						1		1	2	4	6	6	6	3	2	3		1				35
15-6 " 15-11		1						1	2	3	7		3	5	2	3	2		1	1		31
16-0 " 16-5					1			2		3		1		1	1	1			2			12
16-6 " 16-11												1			2							3
17-0 " 17-5																	1					1
17-6 " 17-11											1											1
18-0 " 18-5																					1	1
Total	4	18	22	30	21	25	14	33	19	36	37	31	18	14	9	10	3	1	3	1	1	350

a second or third time to be rated good, or at least fair in scholarship.

Let us now turn from this picture of retardation, probably no worse in Detroit than in the other cities, and look for the causes. I now present the results of the Binet examination in Table II (See page 276). The range of mental ages is from three years to over sixteen years. We find here, not marked retardation, but a high acceleration amounting in several cases to four or five years. Again, if we accept the same range for normal progress as before, we find 14 retarded pupils, 92 at grade, and 244 accelerated with respect to their mental age. As Terman has pointed out, the problem of acceleration and retardation is exactly the reverse of what was commonly supposed. Judged by the chronological age in Table I, the retardation is heavy: judged by mental age in Table II, retardation is light and acceleration is heavy.

If we accept the dictum that school progress is determined by mental rather than chronological age, there is sufficient ground for complaint that these pupils are unable to do satisfactory work. One can scarcely believe that the same pupils are represented on the two charts. The median chronological age of the group is 13 years and 2 months; the median mental age 8 years and 8 months, a median retardation of 4 years and 6 months.

In many cases it is evident that the pupil has been promoted through inertia of the system. After he has been in a grade for two or three years, the teacher, usually with good intentions, wonders if the pupil won't take on a new lease of life if he tries the next grade. So he is promoted, but change of scenery and new tasks are unable to compensate for lack of ability, and the situation is still as bad as ever, or possibly worse.

It is evident from the development of this discussion that we are dealing with a certain percentage of pupils who are feeble-minded. We prefer, however, to call them backward, and to waste little time attempting to decide whether they are low-grade morons or high-grade imbeciles. In the first place, the Binet test alone is not sufficient ground for such pronouncement,

TABLE II.—MENTAL AGE AND SCHOOL PROGRESS

Mental Age	School Progress																				
	Kg	B1	A1	B2	A2	B3	A3	B4	A4	B5	A5	B6	A6	B7	A7	B8	A8	B9	A9	B10	B11	T
3-0 to 3-5	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
3-6 " 3-11	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
4-0 " 4-5	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
4-6 " 4-11	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
5-0 " 5-5	..	4	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
5-6 " 5-11	..	2	4	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	9
6-0 " 6-5	1	2	8	5	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	19
6-6 " 6-11	..	4	3	8	4	4	..	1	..	..	1	1	..	..	..	..	..	..	..	..	..	26
7-0 " 7-5	..	1	6	8	5	7	1	4	1	..	2	1	1	..	..	..	..	..	..	..	..	37
7-6 " 7-11	..	..	1	2	6	6	..	5	2	..	..	2	..	..	..	..	..	..	..	..	..	24
8-0 " 8-5	..	..	..	..	..	4	6	3	5	7	2	2	1	..	..	..	..	..	..	..	..	30
8-6 " 8-11	..	..	..	2	1	..	4	5	7	6	8	5	3	1	..	..	..	..	..	..	..	42
9-0 " 9-5	..	..	..	..	1	3	1	10	4	7	8	2	2	1	..	..	..	..	..	..	..	39
9-6 " 9-11	..	..	..	3	..	1	1	3	..	3	4	5	2	..	2	4	..	..	..	..	..	28
10-0 " 10-5	..	..	..	..	..	..	..	1	..	7	4	4	1	2	2	1	1	..	..	..	..	23
10-6 " 10-11	..	..	..	..	..	..	..	1	..	1	4	5	1	1	..	1	..	..	..	..	..	14
11-0 " 11-5	..	..	..	..	..	..	..	..	..	4	1	2	2	3	1	1	..	1	..	..	..	15
11-6 " 11-11	..	..	..	..	..	..	..	..	..	1	2	1	1	4	2	2	..	..	..	..	..	13
12-0 " 12-5	..	..	..	..	..	..	..	..	..	..	..	1	..	2	2	..	..	..	1	..	..	6
12-6 " 12-11	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	2	..	..	..	..	4
13-0 " 13-5	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	1	..	..	..	..	..	4
13-6 " 13-11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
14-0 " 14-5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14-6 " 14-11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15-0 " 15-5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1
15-6 " 15-11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
16-0 " 16-5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	2
Total	4	18	22	30	21	25	14	33	19	36	37	31	18	14	9	10	3	1	3	1	1	350

and in the second place, recent studies of intelligence upon large numbers show that the level of average adult intelligence is not so high as it was formerly supposed to be.

After two or three examinations extending over years, supplemented by auxiliary tests and extended observation, we are reasonably safe in diagnosing a few cases as feeble-minded. A very small percentage are recommended for institutional care. The range of I. Q.'s of the group reported in this study is from 29 to 104, median 71. There are 17 whose I. Q.'s are less than 50, and 17 more than 90 (See Table III, p. 278). For our purposes in serving the schools, the mental age is of much more significance than the Intelligence Quotient.

The chief issue of intelligence testing which concerns the schools themselves is not what the I. Q. is, or how the pupils are classified, but what the Clinic recommends. The recommendations for these 350 pupils, together with 40 others already in special classes, or brought in by other organizations during December (a total of 390), are given in Table IV (See page 278).

The special classes in Detroit are well organized and can handle approximately 2,000 at a time. The capacity of these classes is probably sufficient to handle those needing constant individual attention. If we remember that in the scale of intelligence, the percentage of the very backward is small, not more than 2 or 3 per cent of the school population, we see why this provision is adequate. It does not, however, solve the entire question of the slow pupil. The next 15 or 20 per cent of the pupils rated on the intelligence scale, while not in need of constant individual attention, are still unable to succeed unless they have more individual attention than the traditional system offers. Such pupils are to be accommodated in the future in what will be termed slow-moving sections. Minimum courses of study, with coaching wherever necessary, will tend to give pupils such as we have been discussing an opportunity to make the most of their talents.

There is nothing new or striking in this report. All the things that have been hinted at here have been brought to our attention forcibly by Dr. Terman and others. In order to

remind ourselves that it is not theory alone, we close by noting that such work is regular routine in the Detroit Psychological Clinic.

TABLE III

Intelligence Quotients

Range	*Frequency*
Under 35	2
35–39	1
40–44	2
45–49	12
50–54	12
55–59	39
60–64	43
65–69	50
70–74	59
75–79	50
80–84	39
85–89	24
90–94	5
95–99	8
100–104	4
Total	350

TABLE IV

Recommendations

Institution	2
Miscellaneous	20
Work	11
Special A	77
Special B	135
Special Preparatory	9
Demotion	10
Coaching	62
Ungraded	21
Change of School	4
Regular Grade	37
Total	390

Psychological Clinic
Detroit Public Schools
Detroit, Michigan

A FUTURISTIC THEORY OF CONSCIOUSNESS

THEODORE S. HENRY

Any philosophy of education that is worthy of the name rests upon some attempt to explain the nature of mind, and is conditioned upon and largely determined by that particular theory of the nature of consciousness which thus underlies it. The dogma of formal discipline was a logical consequence, if not an actual outgrowth, of the soul theory. Granting the existence of the soul, what more natural than that education should be regarded as having for its chief task the discipline of that soul's various faculties? The theory of the mind as made up of "mental states," which in effect is only a faded-out version of the soul theory, because of its insistence upon the "formation" of the mind by the presentation of ideas from outside sources and by complexes of "associations," lent itself admirably to that form of educational philosophy which we know under the name of "Herbartianism."

Modern educational practice, with its emphasis upon the "problem" and the "project," grows out of an educational philosophy of which Professor Dewey, perhaps, has been the chief exponent. One cannot arrive at an adequate understanding of any form of educational practice without some knowledge, at least, of the philosophy underlying it; and this, in turn, requires an understanding of the psychological principles which are involved in it.

To be more specific, no one can fully understand these newer movements in education without giving some consideration to a certain theory of the nature of consciousness, which is fundamental to the educational philosophy by which they are justified and the educational psychology through which their methods are derived. It will be the province of this paper to discuss this theory, given to us by Dewey and probably best worked out by Professor Boyd H. Bode.[1]

[1] Boyd H. Bode, *Consciousness and Psychology*, in *Creative Intelligence, Essays in the Pragmatic Attitude*, by Dewey and others.

In the animal organization as we find it in man, its highest type, provision has been made for two general classes of responses. Of these, one is made up of responses that are simple, "mechanical," and fixed, so that they can be predicted. Responses of the other kind are complex, "intelligent," and varied, so that it is extremely difficult, or indeed impossible, to describe them in advance. Commonly we call such responses as those of the first type "instinctive," or "reflex" acts, and of these two terms the second is preferable, at least in the large majority of cases. Responses of the second type are called "intelligent," "conscious," or "purposive."

So far as reflex behavior is concerned, the theory which we are discussing does not far depart in its teachings from those accepted by psychologists in general. In Dewey's conception of the nature of the "conscious" or "intelligent" act, however, a distinct line of cleavage separates him from those who hold to any form of the old soul theory, or to the more modern and perhaps more scientific theory of "mental states" or "mental processes." Whatever differences there are in these sorts of theories, they are alike in that, if followed to a logical conclusion, they seem in common to posit, for the substratum out of which the intelligent act arises, some separate and distinct entity, namely, the "soul," "mind," "consciousness," or "intelligence." Now this separate entity is by Dewey ruled entirely out of account, a circumstance which, we must admit, gives him the advantage of the minimum of assumption and consequent economy of explanation.

As I have said, many of the actions which go to make up human behavior are of a nature such as we call reflex. In other words, they are responses to mere physical stimuli, provided for by inherent organization of the nervous system. As such, they are just as mechanical as the firing of a gun when the trigger is pulled, and just as certain and unvarying. In this field of behavior, there is absolutely no need for "mind;" indeed, under such circumstances as call forth these acts, "mind" would be only in the way, as an active agent, that is, and could find room only for being an interested onlooker.

In the lower forms of animal life, nature has been prodigal in providing such responses, so much so that mechanical behavior is adequate for all the needs of the organism. In the case of the higher animals, however, especially in man, reflex behavior breaks down in its ability to cover all situations. Man pays for the increased complexity of his nervous system by this failure of his sum total of reflexes to meet all his needs. Indeed, because of this very complexity, "conflicts" and "blocking" of responses may take place.

Some new situation may present itself, which two different and opposing reflexes attempt to take care of. Their natural antagonism leads to conflict, and action is "hung up," so to speak. It is in just such situations as these that "consciousness," "mind," or "intelligence" functions. That is, whenever and wherever reflex behavior loses its adequacy to meet the situation, a higher type of behavior must step in to take care of it. Response to mere physical stimuli breaks down, and a response to something of a different nature begins to operate.

The nature of this latter type of response may, perhaps, be best shown by an example. Just a few moments ago I picked up my fountain pen from my desk. It had been lying there in plain sight for a long time, and my eyes had often rested upon it. That is, it had been presenting direct physical stimulation, but no response had been evoked. Any response that might have taken place while the fountain pen was exerting only a mere physical stimulation would have been reflex, and there was no opportunity, under the particular circumstances, for reflex behavior to come to overt manifestation. But, as I say, after a while, I did reach out and pick up the pen. The question now is: Just why did I do this?

The "common sense" answer to this question might be that I picked up the pen because I "wanted" it or "needed" it. As a matter of fact, I had been trying to compose at my typewriter, but had come to a place where progress was becoming slow and difficult, and I resorted to the use of my pen. Common sense again would say that the act of picking up the pen

was controlled by "mind," thus making necessary a third party to the transaction, — that third party which futurism rules out.

Disposing of the "mind" in this way, and remembering that it is the body which engages in the performance of the act, we have left as the instrument of control only the pen. Let us say, then, for the sake of the argument if for nothing more, that the pen controlled the act. In that case, evidently, something must have happened to the pen, for it had been lying on the desk for a long time without exercising any such control. In other words, it had become more than a mere physical stimulus, or, supposing that it had been *something* more than mere *physical* stimulus, it had obtained more than marginal position. It had become pen-to-be-picked-up; it had taken on *meaning*, something which it had not previously possessed; for up to this time, while my typewriter was sufficient for my needs, the pen had not meant anything to me.

Again, as soon as it had been picked up, it became pen-to-write-with. That is, the response and the stimulus reacted upon each other, for if the stimulus had not shown progressive change as the response was carried out, action either would have been blocked, or would have run reflexly on to completion.

We must note that this meaning, which passes through this progressive development, is essentially futuristic. This is not to say that previous experience is unnecessary, but it was anticipation of the future consequences, rather than previous experience, which exerted the *control* that made me pick up the pen. It was not pen-that-I-have-written-with, but pen-to-write-with. Meaning, then, is the transference of future possibilities into the present, so that future consequences exert a real control over present acts.

To apply this to objective qualities, *hard* means *will resist*, *sharp* means *will cut*, *hot* means *will burn*. In this way, the present and the future meet. The future is transferred into the present and exercises a control over behavior, *and that control is the essence of consciousness.* As Dewey puts it, "Mind is capacity to refer present conditions to future results, and

future consequences to present conditions."[2] "Mind appears in experience as ability to respond to present stimuli on the basis of anticipation of future possible consequences."[3] Although previous experience is indispensably conditional, the act of the present moment, the act with which I am *now* concerned, reaches into the future and is controlled by consequences that are as yet in the future, although read off as present.

This conception of consciousness as behavior controlled by ends, or future consequences, is somewhat more difficult to set up in explanation of the first experience than in explaining later activity. Suppose that a child for the first time sees a lighted candle. By the conditions, the stimulus here would be a purely physical one, and if reflex activity is adequate to the situation, we need not assume the responsive act as "intelligent." But if there is any conflict of responses, by the conditions also we have a conscious situation, for reflex activity has failed to secure adjustment, and some response must be singled out.

If the act of reaching for the candle is the one that emerges from this conflict, the end value of the lighted candle as object varies at once; it becomes exciting, urging, thing-to-be-grasped. The act of reaching is reflected into the outcome, whether it be good or bad. I mean by "outcome" the adaptive value of the nascent act if carried on to completion.

If this act goes on to completion and the child's fingers are burned, the next response to the situation of the lighted candle will be different. The act of shrinking or withdrawal will be evoked, and the child's body will behave as if it were already being burned. The candle flame has acquired meaning through past experience, but it is future burning that becomes present and controls the act of shrinking. The candle has taken on new meaning and the child has begun to be educated, for education is the process of supplying new meanings, or, to put the same idea into other words, education is the process of changing the nature of stimuli.

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[2] J. Dewey, *Democracy and Education*, p. 120. [3] *Ibid*, p. 153.

PSYCHOLOGICAL DIAGNOSIS AS AN AID IN SOLVING EDUCATIONAL PROBLEMS *

GERTHA WILLIAMS

I am presenting a report of an experiment begun in Detroit in the fall of 1917. For a number of years previous to that date I had been interested in the problem of retardation, more particularly in the possibility of the restoration of backward children to the regular grades. I had come to the conclusion that this constituted a practical school problem. In October, 1917, with the permission of Mr. Cody, the restoration room was opened in the Detroit Normal College, now the Detroit Teachers College.

The purpose of the room was and is twofold, the practical purpose of restoring backward children to the regular grades, and the scientific one of the study of the problem of retardation. Although it is in its fourth year, we feel that the experiment is really only two years old. At the close of the first year of the restoration room, the teacher felt the need of further preparation, especially in psychology, and spent the following year in training. Thus the experiment was interrupted.

Upon her return in the fall of 1919, we made a fresh start, so we feel that the experiment really began then. Moreover, we feel that the work is still in an experimental stage, and we are not presenting it as a finished experiment. We have been confronted with many problems which we have been unable to solve, and we ask your aid in surmounting these obstacles. We have reached some tentative conclusions and of these we ask your criticism.

First, I wish to say a few words as to the organization of the room. The class is limited to fifteen children, who are

* With one exception, the charts and tables used in the oral presentation of this paper have been omitted.

under the direction of one teacher, five hours a day, for the entire school session. The children are all selected from the first three grades. The teachers report through the principals the children who are failing in the first three grades. We also watch the promotion rolls for the failures and cases are reported to us by the Psychological Clinic. The children thus found are then given an individual examination, followed by a qualitative analysis of the child's assets and defects.

On the basis of the qualitative analysis, we decide whether the child *has a possibility of restoration*, and, if the prognosis is favorable, we take him into the restoration room. He is kept there until he is ready to go back into a regular grade with the probability of being able to keep with that grade, or until we are convinced that he is not a restoration case. In the latter event, he is either placed in a special class for deficient children, or returned to a regular grade until there shall be a vacancy in a special class.

Putting a new kind of special class on the market is like introducing a new religion. It needs justification. I know you are wondering just how these children differ from special-class children. The type of children whom we call restoration cases differ from special-class children in that they are children of average level of intelligence, but with special defects, while the special-class child is below the average level of intelligence, and, as a rule, the mental traits are pretty much on a level.

A few cases will, I think, illustrate what I mean. Dorothy had difficulty in making the association between the printed or written symbol and the name of the word or letter. She was a nervous child and had acquired some bad habits of attention, due probably to her defective imagery and consequent difficulty with school subjects. In spite of a normal level of intelligence (I. Q. 106), Dorothy's proficiency in reading after two terms spent in grade B1 was practically nil. Fortunately, she had little difficulty in making the association between the spoken symbol and its name.

Our problem with Dorothy was to reduce as much as possible the number of associations she would need to make. Conse-

quently, she was taught the names of the letters of the alphabet, as this involved only twenty-six symbols. Very laboriously she made the association between the printed or written symbol of the letter and its name. Having made this association, Dorothy had a valuable tool to help her in the recognition of words. By spelling the word aloud she could recognize it. This was a slow method of recognition, but one she discarded as soon as the direct association between the word and its name had been made. Its particular value for Dorothy was that it gave her a tool which she could use for herself without the aid of the teacher.

This type of child we have found needs training in self-help and methods of study. As far as possible, we teach the children to analyze their own difficulties and so intelligently apply the remedies we devise. Phonics also was a valuable aid to Dorothy as the key word formed a sort of hook upon which she could hang a number of other words, and so again reduce the number of associations it was necessary to make.

The Aldine rhymes were a help to her, as also picture-word associations. The particular value in them lay in the fact that they were all tools which Dorothy learned to use for herself, to dodge, as it were, her difficulties. She could even recognize new words by analyzing them into parts which she already knew. Her progress was slow at first while she was learning the elements, but was much more rapid once the foundation was laid. Last fall we felt that Dorothy had acquired a sufficiently large vocabulary to keep up in a regular grade. She has been making satisfactory progress in the regular grades since that time.

Anthony was a very different type of case. He had no innate mental defects, but, because of faulty discipline at home, he was lacking in initiative and took an unfortunate emotional attitude toward the school and his work. His father "hated a dirty, sassy kid," so Anthony was not permitted to play like other children, nor to take his part in children's quarrels. He was attired in a spotless white sailor-suit, or a blue serge one, carefully pressed and brushed, his hair was parted in the middle, and his face and hands were never dirty. He was never

allowed to play on the floor, since that would soil his expensive suits. He was taught that he was unable to do anything for himself, even to put on his own rubbers. These things were not done for Anthony with the usual motherly solicitude, but he was given distinctly to understand that they were being done because he was totally unable to do them for himself.

Ideals at home and in school clashed. In school, it was a virtue to put on one's own rubbers. At home, it was a virtue not to do so. Thus it was with everything. Is it any wonder that Anthony sought defence in a sort of negativistic attitude? He found it safer to do nothing at all, since anything he did was likely to lead one into trouble. Moreover, Anthony found that the whole world, his whole world at all events, was his enemy — his parents, teachers, playmates, everybody.

Anthony illustrates well the maxim that education begins with a generation more or less remote. It was a hard task to change the attitude at home, but in time it was changed at least as much as the intelligence of the parents made possible. And it was a long, hard task to change Anthony from the Lord Fauntleroy type of child, immaculate, inactive, sullen, into a real, romping boy with a pompadour, a rosy face none too clean and a more sunny disposition. It was a great triumph, moreover, when Anthony wrote this item for the room newspaper, "Anthony likes to come to school now. He likes to do hard work. School is a good place to come to. Anthony likes Miss L. He has three good papers today."

I shall cite one more case, that of Grace who had so serious a speech defect that when she dropped in upon us one day with no card to tell whence she came, she was unable to tell us even her name, so that we could understand it. She had been ridiculed so much, both by her family and her playmates, that she had become a shy, timid child with almost no confidence in herself. She illustrates what we so often find, that one defect breeds others. Of course, Grace's speech was the point of attack. We felt it adequately accounted for the fact that she was quite unable to read after spending two terms in grade B1.

As Grace's speech improved, she learned to read and her

progress was rapid. Her confidence in herself was developed by the helpful spirit of the children in the room. They praised her when she succeeded and encouraged her when she failed. The climax came when Grace recited before a whole roomful of strange children a poem she had learned. The last report of Grace states that reading, which had been her Waterloo, is now her easiest subject.

You will see from these few cases that the treatment in each case is individual, and depends entirely upon the nature of the defect. We have found psychology very helpful in diagnosing the nature of the child's difficulty, and that diagnosis is always followed up with remedial measures appropriate to the defect discovered. We like the term Dr. Witmer uses, "diagnostic education," although, perhaps, we are presumptuous to use that label. It is a kind of selective educational treatment, every step of which is determined by the findings of the analytical diagnosis, a continuing diagnosis made not entirely at the time of the first examination of the child, but throughout the period of training.

You may be interested in the number of children we have been able to restore to grades in the four years of the class. The following table will show this by years.

TABLE SHOWING THE WORK OF THE RESTORATION ROOM

Year	No. of cases	Duplicates	No. of cases excluding duplicates	No. restored	Duplicates	No. restored excluding duplicates	Per cent. restored	No. not restored	Duplicates	No. not restored, excluding duplicates	No. of doubtful cases	Remarks
I	18	0	18	3	0	3	19	13	0	13	2	1 left 1 in B5
II	15	9	6	3	1	2	20	12	8	4	0	
III	25	0	25	15	0	15	80	4	0	4	5	1 left 1 still in room
IV	20	5	15	18	0	18	90	1	0	1	1	still in room

The children, after leaving the restoration class, are followed up by questionnaires, and by visits to the schools. The percentage restored you will notice has increased rapidly. That is due to two causes, better selection and better teaching. The first class of children which we assembled in the restoration room was really a high type of special class. At least ten of the eighteen children should have been in a special class, although not of the type generally so placed. We know now that we cannot restore such cases, and therefore exclude them from the room.

A second cause of a higher percentage is that our methods of treatment have improved. We had one child in the first class (I. Q. 98) who had difficulty in making the association between the written or printed symbol and the name of the word or letter. As we recall him now, he seems very similar to Dorothy, whom we have been able to restore.

There are two other methods of caring for backward children which may seem to overlap this method. One is the tutoring system and the other the division of children into groups for teaching in accordance with their intelligence level.

The division of all regular grade children into three groups on the basis of intelligence level has been tried very successfully in Detroit in the first grade, and probably will be extended up through the grades. It has been found that the middle or Y group can cover in one semester the course designed for one semester, the upper or X group can accomplish two semesters of work in one semester, and the lower or Z group can do only half a semester's work in one semester.

In time, special courses of study will probably be worked out for the X and Z groups. Undoubtedly, the Z group will take care of some of our backward children, but probably those of one type, namely, those whose retardation is due to a low general level of intelligence (but not as low as that of the special-class child). But the child with a special defect will fit no better in the Z group than in the older organization. For him, a method of teaching designed for his special needs is necessary.

The tutoring system also can take care of only a small percentage of these cases. By the tutoring system I mean the unassigned teacher, who takes the children who are not making progress in their regular grades, in groups of from five to fifteen for periods varying from fifteen minutes to half an hour a day. Where I have seen the tutoring system in operation, it has been quite ineffective, partly because of faulty organization. Groups of children have been taken from the regular grades who have nothing in common, except the fact that they are failing in arithmetic, spelling, or both. The unassigned teacher has taken them, and given them more of the same type of material they have been failing on, and presented it in the same way. No attempt has been made to discover the cause of the child's difficulty; no tests have been applied, either educational or psychological.

Children have been thrown together in a hit-and-miss fashion; some of them have been feeble-minded, others disciplinary, and so forth. Properly organized, the tutoring system would be especially adapted to the children who, through absence, half-day sessions, or any similar cause, lack adequate preparation for the grade in which they are. Educational tests could be applied to discover where the preparation has been inadequate and the drill directed to the particular weakness manifested. We have had a number of cases of this type in the restoration room.

Most of our children have required a longer period a day than fifteen minutes to half an hour. Sometimes five hours a day seem all too short. This is particularly true of the cases of emotional instability, lack of initiative, or bad habits of attention. And these defects are quite common in these cases, especially as secondary defects.

A combination of the tutoring system and the restoration room might be made by organizing the class in such a way that there would be some permanent residents and others coming in for shorter periods.

Our present method of selecting children for the restoration class has not been wholly satisfactory. As stated above,

children who are failing in the first three grades are reported by the teachers through the principals. We add to this list children reported to us by the Psychological Clinic and children who have failed of promotion. Each of these children so reported is given an individual examination. On the basis of our findings on the individual examination we choose the children for the room.

The individual qualitative examination is wholly satisfactory. We use a number of tests varying with each child, emphasizing particularly the attempt to teach. We can almost invariably prognose the case from this qualitative analysis. It is the first rough selection which we find unsatisfactory. Teachers report feeble-minded or disciplinary cases, and fail to report the type of child who would most profit by the restoration room. We need some kind of examination which will sift out these children for us quickly. Group intelligence tests do not do this; the child with a special defect often makes a high score on such a test.

We have one child in the restoration class now whose score on a group intelligence test is among the highest 20 per cent in the city, yet he failed of promotion last June. This is no criticism of the group intelligence test. It is designed to test general level of intelligence, not specific mental traits. An analysis of the separate tests in the scale might help us. We have not had time to make such a study.

For the same reason, the I. Q. on a Binet test does not help us very much. We have had several children with I. Q.'s ranging from 85 to 100 whom we have been unable to restore. It is possible that these I. Q.'s will drop on subsequent examinations. That is another study we are reserving for the halcyon days of the future when we have more time. Whether we can get any help from the Binet basal age, the amount of scattering or the score on certain types of tests (e.g., memory span), we do not know. We lack data on the scores of children perfectly normal in these respects.

Scores on educational tests would be of great benefit to us, but unfortunately there are so few tests for the first three grades. We find the Haggerty Reading Test of great value to

us, and expect to use Miss Heller's B 1st vocabulary and sentence tests as soon as norms are available. But we need similar tests in arithmetic. Such tests combined with the scores on group intelligence tests would help in selecting the children for the restoration class. Moreover, the educational tests would help in discovering the type of difficulty which the child has, in measuring his progress in the restoration class, and in determining when the child is ready to return to a regular grade.

One by-product of our study has been the discovery that there are many children for whom there is no place in the educational system. I refer to the children with I. Q.'s between 80 and 100, who, in spite of high I. Q.'s, are not restoration cases. These children are misfits in the regular grade, misfits in the restoration room, and their high I. Q.'s exclude them from the special class. A few of them have, upon our recommendation, been placed in a special class in spite of the high I. Q.'s and seem to fit in there very well (I. Q.'s 86, 81, 96, 80).

Our experience makes us doubt whether one ought to accept the Binet label as infallible. We are inclined to believe that some of the children with I. Q.'s even from 75 to 90 are true special-class cases. This is not a criticism of the Binet scale. In the hands of a clinical psychologist, it is a valuable tool, but I do not believe that the Binet or any other test can be refined to the point of being an infallible measuring stick for so complex a thing as intelligence. A percentage of cases at least will need further examination by an expert clinical psychologist.

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THE COLEOPTERA OF THE SHIRAS EXPEDITION TO WHITEFISH POINT, CHIPPEWA COUNTY, MICHIGAN

A. W. ANDREWS

GENERAL DISCUSSION

Through the courtesy of the Honorable George Shiras 3d, the Museum of Zoology was enabled to undertake a biological reconnaisance of the Whitefish Point region in the Northern Peninsula of Michigan. The expeditions were two in number, one in the early part of the summer of 1913, the second three weeks later in the season during 1914. The writer was a member of each expedition, and spent a total of about one month in the region.

Whitefish Point is a northeast extension of Chippewa County into Lake Superior. Its general topography may be briefly summarized as consisting of series of sand and shingle ridges roughly parallel to the shore-line and with a maximum height of about sixty feet. In the depressions between the ridges rather extensive marshes occur, with occasional ponds or even small lakes. The ridges carry a stand of mixed hardwood and conifer, the marshes have both grassy areas and the typical brush of the region, and on the few sand flats the jack pine is usually in evidence. The various habitats are described in detail in the proper places in this paper.

A considerable number of insects other than beetles were collected by the writer and several of the groups have been reported upon, either by himself or by his colleagues of the expeditions. This diversity of the insect collections affords considerable data for a geographic interpretation of the region. In the case of beetles a number of forms considered as British Columbian and Californian were taken, as well as eastern species common in New England and northern Ontario. In

addition to these, there were forms of strong southern affinities, even of Georgia and Florida, that are unrecorded from southern Michigan or are very rare at the latitude of Detroit.

Some interesting relations of reactions of insects to the weather conditions were noted in 1913. From June 30 to July 2, the wind was southeast, and warm, sunny conditions prevailed. About 4 A.M. on July 3, the wind veered to the northwest and the weather turned very cold. The wind caused a large sea on Lake Superior, with a heavy surf along the beach. In winter attire the writer went out along the beach and found conditions which entomologists could scarcely imagine. Apparently all the insects of the Northern Peninsula were out in the cold water or crawling ashore. In a distance of three or four miles tens of thousands were to be seen. Ants lay in regular windrows, several species of chrysomelid beetles occurred by the thousand, buprestids and cerambycids with many other groups were present in great numbers everywhere.

With the shift in the wind in the early morning, the last insects flying the previous night were blown out, and were consequently the first to come in, whereas later in the day there appeared the groups blown out twenty-four or forty-eight hours earlier. The insects came in almost recognizable waves; the first ones out were the last to come ashore.

For a period of about twenty-four hours, the wash-up produced the following results. During the first few hours, the insects appeared to be largely night-flying species, moths in good condition, and in the Coleoptera the night-flying form such as Curculionidae, Buprestidae, Elateridae and Chrysomelidae. Some of the latter appeared in great numbers; all were in perfect condition and normally active. Later ants came ashore in numbers; they were almost all dead on the beach. Still later came butterflies, miscellaneous Hymenoptera and Diptera with them, and last of all were the bees. The majority of these insects were dead and badly mutilated by the surf, but not a few dispersed inland when they were dry.

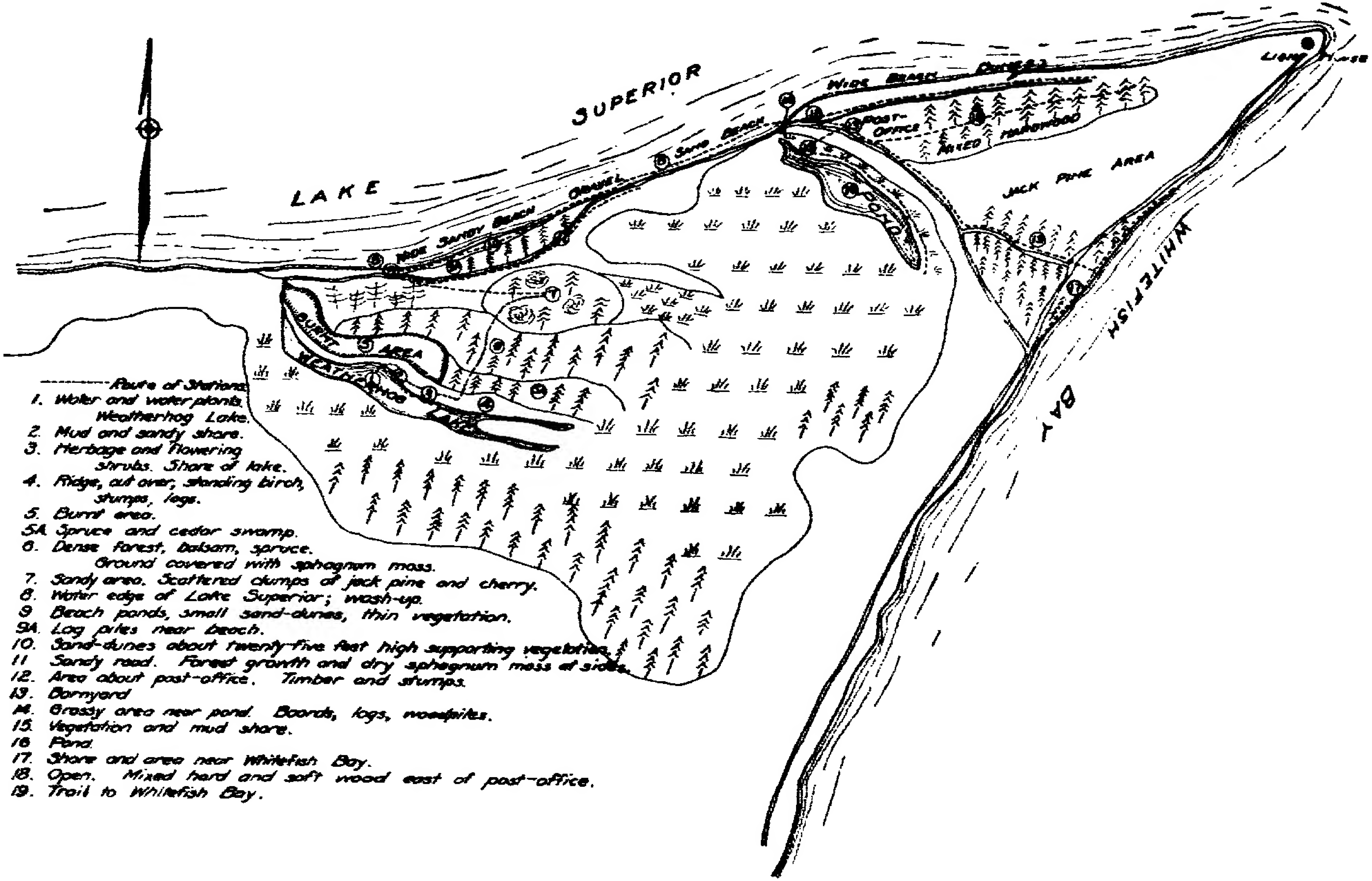
Many of the insects are eaten by birds, especially by crows. These beach-combers follow the debris line during all hours

of daylight, and the collector gets what they leave, or what accumulates when the wind and cold drive the birds to shelter. The fine, constantly drifting sand covers and destroys large numbers as well, so that every minute must be utilized while the conditions last.

This abundance of various species as beach debris does not always occur with a storm. The previous conditions of wind and temperature are important factors in causing the free movement of insect life out over the Lake. In this connection it is interesting to note that at Whitefish Point a sector some three-quarters of a mile long proved to be especially rich in beach debris. A series of lakes, ponds and marshes runs back several miles and constitutes a long open area which gradually widens toward the shore. The effect is that of a funnel, as the insects moving into the open and more or less with the wind were driven out over the Lake, and, with the change in the direction of the wind, were swept back upon the particular beach area they had left.

The conditions necessary to produce the phenomena along the shore seem to be several days of warm, sunny weather with gentle warm winds and preferably a short thunder-shower, followed by a rapid shift of wind to a cold quarter with an exceedingly sudden drop in temperature.

The second trip in the region began July 19, 1914, and ended August 3. On this trip, the presence of Mr. McAlpine and Mr. Combs, two other entomologists, allowed the writer to give his exclusive attention to the Coleoptera. A different line of work was followed this second season, a study of Coleoptera successions. A number of stations running in continuous lines were established and minutely examined for all forms. A detailed account of the stations (See Map V) and the procedure with its results will be found in the body of the paper. The first station was a long, shallow pond or small lake, called locally Weatherhog Lake (Long Marsh Lake). Briefly, the conditions were as follows: the lake was bordered with a low marshy area on one side which in turn was edged with woods; the other side was bounded by a ridge, partly wooded, partly



Map V. Sketch Map showing Coleoptera Stations at Whitefish Point, Chippewa County, Michigan.

covered by stumps and log piles. In the water were a number of aquatic plants, which proved to be the home of such chrysomelids and curculionids as usually live under such conditions. The water was dredged for water beetles, and the narrow shore sand and mud searched for its beetle fauna. Of other groups which did not make the flowering shrubs and plants growing along the shore their habitat, a number were taken.

The slope of the ridge covered with shrubs was not inhabited by many forms; on the crest, the stumps produced bark beetles, staphylinids, etc., and the log piles and dying trees afforded buprestids and cerambycids.

A burned-over area with the ashes still smoking proved a most interesting station. The writer arrived at the site a few hours after the fire had started and was able to observe some of the insect movement caused by such abnormal conditions. In many places, the thick undergrowth impeded observations, but a fairly clear spot was found and conditions on the forest floor were noted.

The most obvious effect was the general movement from the burning area by the ground beetles, the Carabidae. These beetles, together with Staphylinidae and spiders dragging their cocoons, were all moving from the fire. One species of buprestid, *Melanophila longipes*, appeared in great numbers flying about the burning area, and even alighting on the hot ashes and burning stumps. Several were noted eating the half-roasted larvae of wood-boring insects exposed by the bursting bark. Many Cerambycidae were noted flying away from the area.

After the fire had died down, a number of species were taken on scorched tree-trunks. The open space consequently exposed to the sunlight seemed to attract several species of butterflies and dragon-flies, but was free from mosquitoes and other Diptera, although the surrounding woods swarmed with them.

The next station on the line was a thick growth of balsam and spruce, with a dense ground-cover of loose sphagnum moss. The moss afforded cover to a large number of some eight or ten species of carabids, and about the same number of staphy-

linids, while here and there under logs and about the bases of trees were various other beetles, some of which, for instance water beetles, were about to hibernate.

The next station, a more or less dried cedar swamp, that had been cut over, did not produce much. It merged into a sphagnum bog, bordered by a thick growth of tamarack with alder and willow thickets. A few species, but not many individuals, were secured here by beating. On the other side of the bog, there was a flat damp area of mixed loam and sand. It produced few forms. Bordering this, was a flat sandy area, covered by isolated clumps of trees, cherry, jack pine and birch. Tiger beetles, cerambycids, and chrysomelids comprised the insect life of this station.

A shift was then made to the lake shore. A straight line starting at the water's edge was run to the station in the balsam-spruce station at right angles to the previous line.

The beach for a distance of seven or eight feet from the water is firm. A number of species of insects were to be seen here close to the water. They were largely predacious forms, feeding on the insect debris, dead and alive, and living under the logs and stones. The night-feeding species were found in adjacent shelters. On the sandy flats at this point, numbers of Cicindela were seen. As the conditions were most favorable, they made it their habitat. The fine, loose sand is a sufficient barrier to many other insects that do not run freely over it.

Two or three small willows were infested with plant lice, and these attracted numbers of Coccinellidae which preyed on them. Numbers of ants were attracted by the honey dew exuded by the aphids. A small dark chrysomelid appeared to use the aphids for the same purpose. On balm of Gilead bushes the cerambycid, *Saperda moesta,* occurred in numbers. The sand drifts in places to form small, low dunes, which are covered with sparse grass. The tiger beetles found here proved to be *Cicindela hirticollis* in all forms from the typical one to an immaculate form without any markings whatsoever. They seemed to keep in groups. The typical form is rare.

The sweet-gale bordering several small ponds does not attract any beetles, but the Diptera seem to use it for shelter. Running parallel with the beach is a sandy ridge twenty to thirty feet high, covered with a growth of wild cherry, June-berry, and small maples. The cherry trees were universally infested with several small species of Chrysomelidae. This ridge slopes down ten or fifteen feet to the shore road, which is bordered by forest. The ground-cover here is a thick sphagnum moss, which afforded cover for many species of Carabidae, Staphylinidae and others. Some rather rare species were found here. On log piles and foliage of trees, a number of good records were secured. Several species of dung beetles were found on the road. This line ran south through the forest and met the spruce-balsam station.

The more important stations examined were as follows: a pond near the post-office, a grassy field near this pond, several woodpiles, and an acre or so of jack pine. In addition, the barnyard received attention, foliage was beaten along the road, and baits were set, all with considerable results. A few other localities were studied, but not as stations.

In conclusion, then, the area of Whitefish Point that was surveyed proved to be a splendid locality for Coleoptera. Many rare and scarce forms were securéd, a fact to be explained by the varied conditions and the amount of insect life along the shore. It is the opinion of the writer that the best time to collect Coleoptera in the region is from June 20 to August 10. Undoubtedly the latter part of August would show a considerable fauna of fungus-eating beetles which was not in evidence while the expedition was in the field.

The specimens secured are in the collection of the University of Michigan Museum, with the exception of about sixty species of "uniques" still in the care of the writer to be used in working up collections made in the Lake Superior region.

No record can be found of work on Coleoptera at Whitefish Point, although collections have been made in the Lake Superiór region. Hubbard and Swartz published a list in 1878. Records of other work can be found in J. L. Le Conte, 1850, *Agassiz*,

Lake Superior; H. F. Wickham, 1896, *List of Lake Superior Coleoptera;* C. C. Adams, 1908, *An Ecological Survey of Isle Royal.*

The writer is indebted to Professor H. C. Fall for many determinations throughout the list. Mr. W. Knaus identified a number of species of the Carabidae, Cerambycidae and Chrysomelidae, Mr. Percy Bolster also determined some of the Carabidae, Mr. John J. Davis the species of Lachnosterna, Mr. J. A. Hyslop many of the Elateridae, and Mr. A. B. Wolcott a number of the Carabidae, Cleridae and some other forms. Acknowledgments are due also to Mr. W. S. McAlpine and Mr. Fenton Combes, who assisted in the field on the second expedition, and to Mr. and Mrs. Frank House and family and Mr. Benjamin Butler, who gave help in every way possible. Mr. Frederick M. Gaige, curator of the Division of Insects of the University of Michigan Museum, has helped very greatly in the preparation of this paper. To these gentlemen the writer wishes to express his indebtedness and appreciation of their willing assistance in his work.

DISCUSSION OF STATIONS, METHODS, AND LISTS OF COLEOPTERA TAKEN

STATION 1

This station was a shallow pond, called Weatherhog Lake, about two miles long and half a mile wide at its widest point. A ridge ran for some distance along its northeast shore; the opposite shore was bordered by water plants, sedges and marsh, rising to slightly higher ground containing evergreen trees. The pond was so thickly grown with aquatic vegetation in this area that there was very little clear water. On the northeast shore, with the usual shore vegetation of arrow-root, iris, etc., were a few very narrow sandy or mud beaches. Weatherhog Lake is about three miles southwest of the post-office. The methods used in working this station were as follows: dredging, using the sweep-net for beetles on the sedges, collecting from the water-lily pads, examining the muddy debris, which was raked from the pond and laid out on the sandy shore.

DYTISCIDAE

Laccophilus maculosus Germ.
Coelambus impresso-punctatus Schall.
Hydroporus undulatus Say.
consimilis Lec.
modestus Aube.
Ilybius subaeneus Er.
ignarus Lec.
confusus Aube.
biguttalus Germ.
Coptotomus interrogatus Fab.
Copelatus glyphicus Say.
Agabetes acuductus Harr.
Agabus obtusatus Say.
semipunctatus Kirby.
obsoletus Lec.
Scutopterus angustus Lec.
Rhantus bistriatus Bergst.
Colymbetes sculptilis Harr.
Hydaticus stagnalis Fab.
Dytiscus fasciventris Say.
sublimbatus Lec.
dauricus Gebl.
harrisii Kirby.
Acilius mediatus Say.
fraternus Harr.
Graphoderes fascicollis Harr.

GYRINIDAE

Gyrinus confinis Lec.
affinis Aube.

HYDROPHILIDAE

Helophorus lacustris Lec.
nitidulus Lec.
lineatus Say.
Hydrophilus (Tropisternus) nimbatus Say.
Tropisternus glaber Hbst.
Philhydrus ochraceus Mels.
fucatus Horn.

CHRYSOMELIDAE

Donacia megacornis Blatchley.
hirticollis Kirby.
proxima Kirby.
subtilis Kunze.
rugosa Lec.
emarginata Kirby.
Prasocuris vittata Oliv.

STATION II

This station consisted of small stretches of narrow muddy shore and sandy beaches with weeds, sedges, and moss-like growths, occurring alternately. Vegetable and other debris on the shore-line, small chips from beaver cuttings, and small logs provided shelter for the beetles that take cover in the daytime. Half a mile or more of this shore was carefully examined for beetles, the debris was sifted, and the logs and chips turned over.

In addition to the following determined forms, the following undetermined specimens were taken: Amara sp. ?, two females, under debris, which, as no males were found, could not be identified; cercyon sp. ?, two specimens, in muddy debris.

CARABIDAE

Omophron americanum Dej.
Calosoma frigidum Kirby.
Elaphrus clairvillei Kirby.
laevigatus Lec.
fuliginosus Say.
ruscarius Say.
Dyschirius sphaericollis Say.

Bembidium musicola Hayw.
transversale Dej.
ustulatum L.
scopulinum Kirby.
fraternum Lec.
versicolor Lec.
sulcatum Lec.
anguliferum Lec.
Patrobus longicornis Say.
Pterostichus permundus Say.
lucublandus Say.
caudicalis Say.
corvinus Dej.
Amara exerata Dej.
cupreolata Putz.
erratica Sturm.
obesa Say.
remotestriata Dej.
Badister micans Lec.
reflexus Lec.
Platynus anchomenoides Rand.
obscurus Herbst.
atratus Lec.
melanarius Dej.
cupripennis Say.
variolatus Lec.
bogemanni Gyll.
quadripunctatus DeG.
Lebia tricolor Say.
Cymindis cribicollis Dej.
Miscodera arctica Payk.
Chlaenius erythropus Germ.
sericeus Forst.
diffinis Chd.
tomentosus Say.
Brachylobus lithophilus Say.
Agonoderus pallipes Fab.
Harpalus pennsylvanicus *var.* longior Kirby.
pennsylvanicus *var.* erythropus Dej.
viduus Lec.
erraticus Say.
Stenolophus conjunctus Say.
Bradycellus rupestris Say.
Anisodactylus discoideus Dej.

HALIPLIDAE

Haliplus cribarius Lec.
longulus Lec.

DYTISCIDAE

Bidissus flavicollis Lec.
fuscatus Cr.
Hydroporus undulatus Say.
consimilis Lec.
tristis Payk.
modestus Aube.
dentellus Fall.
Agabus punctulatus Aube.
Rhantus bistriatus Bergst.
tostus Lec.
Acilius fraternus Harr.

GYRINIDAE

Dineutes nigrior Roberts.

HYDROPHILIDAE

Berosus striatus Say.
Helocombus bifidus Lec.
Hydrocombus lacustris Lec.
Hydrobius tessellatus Ziegl.
fuscipes L.
infuscatus Mots.
Sphaeridium scarabaeoides L.
Phoenonotum extriatum Say.

SILPHIDAE

Choleva basillaris Say.

STAPHYLINIDAE

Quedius laevigatus Gyll.
ferox Lec.
vernix Lec.
Staphylinus vulpinus Nordm.
maculosus Grav.
Philonthus umbrinus Grav.
fusiformis Melsh.
Lathrobium simplex Lec.
grande Lec.
Sunius brevipennis Aust.
Bledius borealis Blatchley.

COCCINELLIDAE

Adalia picta Rand.

BYRRHIDAE

Cytilus trivittatus Melsh.
Curimopsis echinata Lec.

HETEROCERIDAE

Heterocerus undatus Melsh.

SCARABAEIDAE

Aphodius ruricola Melsh.

MELANDRYIDAE

Serrophalpus barbatus Schall.

CURCULIONIDAE

Listronotus squamiger Say.
callosus Lec.
Hyperodes humilis Gyll.
Anthonomus rufipes Lec.
Ceutorhynchus septentrionalis Gyll.

CALANDRIDAE

Sphenophorus pertinax Oliv.
robustus Horn.
scoparius Horn.
placidus Say.
incongruus Chitt.
villosiventris Chitt.

STATION III

This station consisted of the flowering shrubs, spirea, willows, and other plants growing along the shore-line of Weatherhog Lake. These plants were examined directly for beetles as well as beaten over the beating-cloth and swept with the sweep-net. All species listed for this station occurred three or more inches above the ground, although many of the species so listed probably do not make this their habitat. The open shore, and the occurrence of the willows, spirea, etc., attracted beetles from a considerable area.

In addition to the species whose names follow, one undetermined species of Leptura was taken.

CARABIDAE

Lebia tricolor Say.
scapularis Dej.
Callida punctata Lec.
Harpalus herbivagus Say.

COCCINELLIDAE

Hippodamia 13-punctata L.
5-signata Kirby.
convergens Guer.
parenthesis Say.
Coccinella sanguinea L.
Anatis 15-punctata *var.* mali Say.
Hyperaspis bigeminata Rand.

NITIDULIDAE

Conotelus obscurus Er.

DASCYLLIDAE

Cyphon variabilis Thunb.

ELATERIDAE

Corymbites cruciatus L.

LAMPYRIDAE

Eros humeralis Fab.
Lucidota atra Fab.
Ellychnia corrusca L.
Photinus pyralis L.
Telephorus carolinus Fab.

CLERIDAE

Trichodes nuttalli Kirby.

SCARABAEIDAE

Hoplia trifasciata Say.
barbata Blatchley.
Trichius piger Fab.

CERAMBYCIDAE

Phymatodes dimidiatus Kirby.
Merium proteus Kirby.

Molorchus longicollis Lec.
Neoclytus muricatulus Kirby.
erythrocephalus Fab.
Aomaeops pratensis Laich.
Gaurotes cyanipennis Say.
Typocerus velutinus Oliv.
Leptura nigrella Say.
nigrella Say, light form.
canadensis Fab.
rubrica Say.
vagans Oliv.
plebeja Rand.
chrysocoma Kirby.
proxima Say.
tibialis Lec.
vitatta Germ.
pubera Say.

CHRYSOMELIDAE

Chlamys plicata Fab.
Bassareus formosus *var.* sulphuripennis Melsh.
Pachybrachys atomarius Hald.
hepaticus Melsh.
autolycus *var.* difficilis Fall.
Adoxus vitis L.
Diachus auratus Fab.
Graphops pubescens Melsh.
Labidomera clivicollis Kirby.
Calligrapha elegans Oliv.
philadelphica L.
multipunctata *var.* bigsbyanna Kirby.
Lina scripta Fab.
obsoleta Say.
Gonioctena pallida L.
Diabrotica 12-punctata Oliv.
Trirhabda tomentosa L.
brevicollis Lec.
flavolimbata Mann.
Oedionychis vians *var.* concinna Fab.
limbalis Melsh.
Galerucella sagittariae Gyll.
Disonycha quinquevittata Say.
Haltica bimarginata Say.
ignita Ill.
cuprascens Blatchley.
Chalepus nervosa Panz.
Coptocyla signifera Herbst.

MELANDRYIDAE

Hallomenus debilis Lec.

PYTHIDAE

Priognathus monilicornis Rand.

CEPHALOIDAE

Cephaloon lepturides Newm.

MORDELLIDAE

Mordella marginata Melsh.

ANTHICIDAE

Anthicus ephippium Laf.

MELOIDAE

Macrobasis unicolor Kirby.

RHYNCHITIDAE

Eugnamptus collaris Fab., color var.

ATTELABIDAE

Attelabus rhois Boh.

OTIORHYNCHIDAE

Neoptochus adspersus Boh.
Pandeletejus hilaris Hbst.

CURCULIONIDAE

Sitona flavescens Marsham.
Lepyrus geminatus Say.
Magdalis hispoides Lec.
Orchestes puberulus Boh.
Anthonomus squamulatus Dietz.
Tyloderma areum Say.
Coeliodes acephalus Say.
vitiosus Dietz.
Ceutorhynchus rapae Gyll.
Rhinoncus pyrrhopus Boh.
Baris subsimilis Casey.
Auleutes subfasciatus Dietz.
Madarus undulatus Say.

CALANDRIDAE

Rhodobaenus tridecimpunctatus Ill.

SCOTYLIDAE

Ips pini Say.

STATION IV

Station IV was a ridge, running for some distance on the northeast shore of Weatherhog Lake, part of it cut over, part of it with standing trees, mostly oak, yellow birch, and paper birch. There were many spruce stumps and several log piles. This station produced a considerable variety of species which must be considered as occurring in their proper habitat.

CARABIDAE

Dyschirius brevipennis Lec.
Tachys nanus Gyll.
    flavicauda Say.
Pterostichus adoxus Say.
Platynus octocolus Mannh.
Harpalus laticeps Lec.

STAPHYLINIDAE

Aleochara lata Grav.
Quedius fulgidus Fab.
Xantholinus cephalus Say.
    obcurus Erichs.
Stenus flavicornis Er.
Lathrobium punctulatum Lec.
    obtuseum Casey.
Stilicus biarmatus Lec.
Lithocharis confluens Say.
Sunius prolixus Er.
    discopunctatus Say.
Tachinus scrutator Horn.
Tachyporus maculipennis Lec.
    jocosus Say.
    chrysomelinus L.
    brunneus Fab.
Conosoma littoreum Kirby.
    knoxii Lec.
Boletobius cincticollis Say.
Bledius tau Lec.

EROTYLIDAE

Mycotretus pulchra Say.

CUCUJIDAE

Brontes dubius Fab.

HISTERIDAE

Hister lecontei Mars.
    basalis Lec.

NITIDULIDAE

Epuraea corticina Erichs.
Ips fasciatus Oliv.

TROGOSITIDAE

Tenebrioides castanea Melsh.

ELATERIDAE

Melanotus glandicolor Melsh.

BUPRESTIDAE

Chalcophora virginiensis *var.* lacustris Lec.
Melanophila fulvoguttata Harr.
Chrysobothris floricola Gory.

CLERIDAE

Enoclerus muttkowskii Wolcott.
Thanasimus undulatus *var.* nubilus Klug.

PTINIDAE

Anobium notatum Say.
Bostrychus bicornis Web.
Ptilinus ruficornis Say.
Dinoderus substriatus Payk.

SCARABAEIDAE

Onthophagus hecate Panz.
Dichelonycha elongata Fab.

CERAMBYCIDAE

Xylotrechus colonus Fab.
undulatus Say.
Neoclytus muricatulus Kirby.
Leptura nigrella Say.
nigrella Say, light form.
tibialis Lec.
mutabilis Newm.
Monohammus scutellatus Say.
confusor Kirby.

TENEBRIONIDAE

Nyctobates pennsylvanica DeG.
Haplandrus concolor Lec.
Tenebrio obscurus Fab.
Hoplocephala bicornis Oliv.
Boletotherus bifurcus Fab.
Boletophagus depressus Rand.

CISTELIDAE

Androchirus erythropus Kirby.

MELANDRYIDAE

Melandrya striata Say.

OEDEMERIDAE

Ditylus caeruleus Rand.

CURCULIONIDAE

Pissodes strobi Peck.
Hylobius confusor Kirby.
Dorytomus laticollis Lec.
Rhinoncus pericarpus L.

SCOLYTIDAE

Pityophthorus sparsus Lec.
Xyleborus celsus Erich.
Dendroctonus punctatus Lec.
valens Lec.

STATION V

This station consisted of a burnt area, which was examined both during and after the burning. The writer arrived at the fire shortly after it started. If the forest floor had been clearer of underbrush, no doubt much more movement of insects would have been observed, since nearly all of them seemed to depend almost entirely on their legs for escape, and the advancing fire was not so rapid but that most of the adults could escape in this manner.

CARABIDAE

Pterostichus mutus Say.
Platynus decorus Say.
crenistriatus Lec.
rubripes Zimm.
Anisodactylus agricola Say.
harrisii Lec.

MYCETOPHAGIDAE

Mycetophagus pluripunctatus Lec.

BUPRESTIDAE

Melanophila longipes Say.
fulvoguttata Harr.
Agrilus anxius Gory.
politus Say.

CERAMBYCIDAE

Monohammus scutellatus Say.
confusor Kirby.

STATION Va

The next station was a spruce and cedar swamp, mostly cedar. Although the fungi were numerous, the number of

species taken would probably have been much greater, had the season been more advanced; it was only July when the collecting was done. No water beetles were found, as the swamp was almost dry at the time.

In addition to the species listed below, several specimens of Atomaria sp. ? (Cryptophagidae) were taken.

SILPHIDAE

Silpha americana L.

STAPHYLINIDAE

Aleochara bimaculata Grav.
Staphylinus fossator Grav.
Lathrobium grande Lec.
Tachinus memnonius Grav.
    luridus Er.
    fimbriatus Grav.
    pallipes Grav.
    nitiduloides Horn.
    circumcinctus Makl.
Boletobius intrusus Horn.
Pycnoglypta lurida Gyll.
Megarthrus excisus Lec.

ENDOMYCHIDAE

Endomychus biguttatus Say.

EROTYLIDAE

Tritoma thoracica Say.

CRYPTOPHAGIDAE

Cryptophilus integer Heer.

MYCETOPHAGIDAE

Mycetophagus flexuosus Say.

HISTERIDAE

Saprinus fraternus Say.

NITIDULIDAE

Epuraea helvola Erich.
    truncatella Mann.
Phenolia grossa Fab.
Omosita colon L.

SCARABAEIDAE

Aphodius hamatus Say.
    ruricola Melsh.

TENEBRIONIDAE

Nyctobates pennsylvanica DeG.
Iphthimus opacus Lec.

CISTELIDAE

Isomira quadristriata Coup.

MELANDRYIDAE

Penthe obliquata Fab.

STATION VI

This station was a dense forest of small spruce and balsam. The forest floor was covered with sphagnum which was so loose that one could lift up yards of it. Underneath the moss were found great numbers of certain species. The moss was sifted, the tree trunks examined, the branches and foliage beaten. Several logs and stumps recently cut attracted some species.

In addition to the following list, one undetermined specimen of Carpophilus was taken.

CARABIDAE

Dyschirius longulus Lec.
Bembidium musicola Hayw.
Pterostichus stygicus Say.
corvinus Dej.
Amara protensa Putz.
Platynus decens Say.
sinuatus Dej.
brunneomarginatus Mann.
anchomenoides Rand.
moerens Dej.
tenuis Lec.
atratus Lec.
affinis Kirby.
carbo Lec.
octocolus Mann.
quadripunctatus DeG.
picipennis Kirby.
Galerita janus Fab.
Anisodactylus baltimorensis Say.

HYDROPHILIDAE

Hydrocharis obtusatus Say.

STAPHYLINIDAE

Atheta plana Gyll.
flaveola Melsh.
punctata Blatchley
sordida Marsh.
aemula Erich.
trimaculata Er.
Heterothops fusculus Lec.
Quedius peregrinus Grav.
capucinus Grav.
desertus Horn.
laevigatus Gyll.
hyperboreus Erich.
Staphylinus violaceus Grav.
Philonthus brunneus Grav.
cyanipennis Fab.
blandus Grav.
apicalis Say.
Xantholinus cephalus Say.
obsidianus Melsh.
Lathrobium grande Lec.
collare Er.
Stilicus angularis Er.
dentatus Say.
Tachinus scrutator Horn.
flavipennis Dej.
picipes Er.
pallipes Grav.
circumcinctus Makl.
Tachyporus maculipennis Lec.
Boletobius intrusus Horn.
pygmaeus Fab.
cincticollis Say.
anticus Horn.
Myceroporus americanus Er.
Oxyporus femoralis Grav.
rufipennis Lec.
5-maculatus Lec.
Oxytelus sculptus Grav.
pennsylvanicus Er.
Trigonodemus striatus Lec.
Olophrum obtectum Er.
Megarthrus americanus Sachse.

ENDOMYCHIDAE

Aphorista vittata Fab.
Endomychus biguttatus Say.

MYCETOPHAGIDAE

Mycetophagus flexuosus Say.

HISTERIDAE

Hister merdarius Hoffman.
Saprinus assimilis Payk.
fraternus Say.

NITIDULIDAE

Soronia undulata Say.
Ips sanguinolentus Oliv.

BYRRHIDAE

Cytilus trivittatus Forst.

ELATERIDAE

Adelocera impressicollis Say.
Alaus oculatus L.
Cardiophorus gagates Er.
Cryptohypnus abbreviatus Say.
Athous reflexus Lec.
Corymbites tesselatus L.
resplendens Esch.
triundulatus Rand.
hieroglyphicus Say.
aeripennis Kirby.

BUPRESTIDAE

Chalcophora liberta Germ.
Dicerca prolongata Lec.
Buprestis lineata Fab.
nutallii *var.* consularis Gory.
maculiventris Say.
striata *var.* impedita Say.
Melanophila aeneola Melsh.
Chrysobothris floricola Gory.

CLERIDAE

Phyllobaenus dislocatus Say.
Chariessa pilosa Forst.

LUCANIDAE

Platycerus depressus Lec.
Ceruchus piceus Web.

SPONDYLIDAE

Parandra brunnea Fab.

CERAMBYCIDAE

Tragosoma harrisii Lec.
Criocephalus agrestis Kirby.
Tetropium cinnamopterum Kirby.
Phymatodes dimidiatus Kirby.
Xylotrechus colonus Fab.
sagittatus Germ.
undulatus Say.
Encyclops caeruleus Say.
Rhagium lineatum Oliv.
Gaurotes cyanipennis Say.
Bellamira scalaris Say.
Leptura tibialis Lec.
Monohammus titillator Fab.
confusor Kirby.
Leptostylus commixtus Hald.
macula Say.
Urographis fasciatus DeG.
Pogonocherus mixtus Hald.
Saperda concolor Lec.

CISTELIDAE

Hymenorus niger Melsh.

MELANDRYIDAE

Synchroa punctata Newm.
Eustrophus confinis Lec.

PYROCHROIDAE

Dendroides canadensis Lat.
concolor Newm.

CURCULIONIDAE

Sitona flavescens Marsh.
Listronotus latiusculus Boh.
nebulosus Lec.

SCOLYTIDAE

Dendroctonus punctatus Lec.

ANTHRIBIDAE

Euparius marmoreus Oliv.

STATION VII

The spruce woods ran down to a quaking sphagnum bog, within which nothing was observed except aerial insects. The bog was succeeded by a sandy area which was Station VII. Small clumps of wild cherry, maple, oak, shad-bush, jack pine, etc., occurred over this area. A number of species were secured by the use of the air-net, the sweep-net, and the beating-cloth.

The following unidentified forms are from this station: Cyphon sp. ?, Cardiopherus sp. ?, Elater two sps. ?, Megapenthe sp. (near *stigmosus*), Melanotus several sps. ?, Serica sp. ?

CICINDELIDAE

Cicindela longilabris Say.
purpurea *var.* limbalis Kl.
hirticallis *var.* rhodensis Calder.

CARABIDAE

Carabus maeander Fisch.
Calosoma frigidum Kirby.
Tachys incurvus Say.
Anisodactylus rusticus Say.
interpunctatus Kirby.

COCCINELLIDAE

Hippodamia 5-signata Kirby.
convergens Guer.
13-punctata L.
parenthesis Say.
Coccinella 9-notata Herbst.
Harmonia picta Rand.
Anisocalvia 12-maculata Gebl.
Mysia pullata Say.
Hyperaspis signata Oliv.

ELATERIDAE

Cardiophorus tenebrosus Lec.
convexus Say.
Cryptohypnus bicolor Esch.
Elater mixtus Herbst.
Agriotes mancus Say.
fuscosus Lec.
Limonius confusus Lec.
basillaris Say.

LAMPYRIDAE

Photinus pyralis L.
Telephorus carolinus Fab.
Podabrus tomentosus Say.

STATION VIII

The next region worked was on a line running from the shore-line of Lake Superior to Station VII. The water edge, and the shore from five to twenty feet back made up Station VIII. Lines of debris and boards were examined, and thousands of insects were observed after a warm land-wind was followed by a shift to the northwest. Immense numbers of insects were washed up in the beach drift; many were crawling for shelter to the debris farther up the beach. If they did not escape in time, they were devoured by the shore birds and crows which combed every inch of the beach after a blow.

CICINDELIDAE

Cicindela repanda Dej.

CARABIDAE

Calosoma scrutator Fab.
frigidum Kirby.
calidum Fab.
Blethisa quadricollis Hald.
Notiophilus semistriatus Say.
Dyschirius setosus Lec.
Clivina dentipes Dej.
impressifrons Lec.
Bembidium carinula Chaud.
inaequale Say.
confusum Hayd.
transversale Dej.
fuscicrum Mots.

Patrobus longicornis Say.
Pterostichus stygicus Say.
relictus Newm.
punctatissimus Rand.
permundus Say.
caudicalis Say.
corvinus Dej.
mutus Say.
luczotii Dej.
erythropus Dej.
Amara rufimanus Kirby.
cylindrica Lec.
crassispina Lec.
fallax Lec.
protensa Putz.
interstitialis Dej.
remotostriata Dej.
musculus Say.
erratica Sturm.
Badister pulchellus Lec.
Platynus moerens Dej.
cupripennis Say.
ferreus Hald.
cupreus Dej.
aeruginosus Dej.
limbatus Say.
ruficornis Lec.
Casnonia pennsylvanica L.
Galerita janus Fab.
Chlaenius nemoralis Say.
pennsylvanicus Say.
tomentosus Say.
niger Rand.
Geopinus incrassatus Dej.
Agonoderus pallipes Fab.
partiarius Say.
Harpalus erraticus Say.
caliginosus Fab.
pennsylvanicus DeG.
var. erythropus Dej.
pleuriticus Kirby.
herbivagus Say.
innocuus Lec.
rufimanus Lec.
viduus Lec.
Stenolophus ochropezus Say.
Anisodactylus nigerrimus Dej.
discoideus Dej.
baltimorensis Say.
terminatus Say.
sericeus Harr.

DYTISCIDAE

Ilybius subaeneus Er.
pleuriticus Lec.
Agabus punctulatus Aube.
subfuscatus Sharp.
confinis Gyll.
erythropterus Say.
Rhantus binotatus Harr.
bistriatus Bergst.
Colymbetes longulus Lec.
sculptilis Harr.
Dytiscus hybridus Aube.
verticalis Say.
harrisii Kirby.
Acilius fraternus Harr.
Graphoderes fascicollis Harr.
Cybister fimbriolatus Say.

GYRINIDAE

Dineutes assimilis Aube.

HYDROPHILIDAE

Hydrophilus triangularis Say.
nimbatus Say.
Tropisternus glaber Herbst.
sublaevis Lec.
Helocombus bifidus Lec.
Sphaeridium scarabaeoides L.
Cercyon centromaculatum Sturm.
praetextatum Say.

SILPHIDAE

Necrophorus orbicollis Say.
tomentosus Web.
Silpha inaequalis Fab.

STAPHYLINIDAE

Quedius hyperboreus Er.

COCCINELLIDAE

Anisosticta strigata Thunb.
Hippodamis 13-punctata L.
parenthesis Say.
Adalia frigida Schn.
Anatis 15-punctata *var.* mali Say.

HISTERIDAE

Hister immunis Er.
Saprinus assimilis Payk.
 sphaeroides Lec.
 fraternus Say.
 mancus Say.

NITIDULIDAE

Nitidula ziczac Say.
 bipustulata L.

LATRIDIIDAE

Coninomus fulvipennis Mann.

BYRRHIDAE

Cytilus sericeus Forst.
 trivittatus Melsh.
Byrrhus americanus Lec.
 murinus Fab.

DASCYLLIDAE

Cyphon variabilis Thunb.

ELATERIDAE

Fornax orchestris Newm.
Alaus myops Fab.
Cryptohypnus abbreviatus Say.
Elater apicatus Say.
Ludius abruptus Say.
 tarsalis Lec.
Agriotes limosus Lec.
Melanotus decumanus Er.
 fissilis Say.
Campylus productus Rand.
Sericosomus incongruus Lec.
Corymbites tesselatus L.
 resplendens Esch.
 cylindriformis Herbst.
 hieroglyphicus Say.
 aeripennis Kirby.
 virens Sch.

BUPRESTIDAE

Buprestis lineata Fab.
 nuttallii *var.* consularis Gory.
 maculiventris Lec.
 fasciata Fab.
 sulcicollis Lec.
 striata *var.* impedita Say.
Melanophila longipes Say.
 fulvoguttata Harr.
 aeneola Melsh.
Chrysobothris dentipes Germ.

LAMPYRIDAE

Eros aurora Herbst.
Photuris pennsylvanica DeG.
Telephorus carolinus Fab.

MALACHIDAE

Collops vittatus Say.

CLERIDAE

Thanasimus dubius Fab.

PTINIDAE

Hadrobregmus errans Melsh.
 carinatus Say.

LUCANIDAE

Ceruchus piceus Web.

SCARABAEIDAE

Onthophagus hecate Panz.
Aegialia spissipes Lec.
Aphodius hamatus Say.
 ruricola Melsh.
 inquinatus Herbst.
Hoplia barbata Blatchley.
Dichelonycha albicollis Burm.
Serica vespertina Gyll.
 carinata Blatchley.
 tristis Lec.
Diplotaxis tristis Kirby.
Lachnosterna dubia Smith.
 rugosa Melsh.
 grandis Smith.
Cotalpa lanigera L.
Ligyrus relictus Say.
Osmoderma scabra Beauv.
Trichius piger Fab.

SPONDYLIDAE

Spondylis upiformis Mann.

CERAMBYCIDAE

Tragosoma harrisii Lec.
Asemum moestum Hald.
Criocephalus agrestis Kirby.
Phymatodes dimidiatus Kirby.
Xylotrechus undulatus Say.
Neoclytus muricatulus Kirby.
Clytanthus ruricola Oliv.
Anthophilax viridis Lec.
Acmaeops proteus Kirby.
  pratensis Laich.
Gaurotes cyanipennis Say.
Bellamira scalaris Say.
Typocerus velutinus Oliv.
Leptura nigrella Say.
  nigrella Say, light form.
  canadensis Fab.
  chrysocoma Kirby.
  tibialis Lec.
  vittata Germ.
Monohammus scutellatus Say.
  confusor Kirby.
Leptostylus macula Say.
Saperda moesta Lec.

CHRYSOMELIDAE

Cryptocephalus venustus *var.* hamatus Melsh.
Chrysochus auratus Fab.
Calligrapha scalaris Lec.
  philadelphica L.
Gonioctena arctica? Mann.
Luperus varicornis Lec.
Diabrotica 12-punctata Oliv.
Trirhabda tomentosa L.
Adimonia cavicollis Lec.
Disonycha quinquevittata Say.
Haltica bimarginata Say.
  punctipennis Lec.
Crepidodera helxines L.

TENEBRIONIDAE

Iphthimus opacus Lec.
Upis ceramboides L.
Haplandrus concolor Lec.
Tenebrio obscurus Fab.
  molitor L.
  tenebrioides Beauv.
Platydema americanum Lap.

CISTELIDAE

Allecula punctulata Melsh.
Hymenorus niger Melsh.
Isomira quadristriata Coup.

MELANDRYIDAE

Synchroa punctata Newm.
Emmesa connectens Newm.
Serropalpus barbatus Schall.
Hallomenus scapularis Melsh.

PYTHIDAE

Crymodes discicollis Lec.

CEPHALOIDAE

Cephaloon ungulare Lec.
  lepturides Newm.

ANTHICIDAE

Notosus anchora Hentz.
Anthicus floralis L.
  ephippium Laf.
  granularis Lec.
Amblyderus pallens Lec.

OTIORHYNCHIDAE

Hormorus undulatus Uhler.
Neoptochus adspersus Boh.
Otiorhynchus ovatus L.
Geoderces melanothris Kirby.

CURCULIONIDAE

Ithycerus noveboracensis Forst.
Hypera punctata Fab.
Listronotus callosus Lec.
Hylobius confusus Kirby.
Notaris puncticollis Lec.
Anthonomus rufipennis Lec.
Miarus hispidulus Lec.
Cryptorhynchus lapathi L.

CALANDRIDAE

Sphenophorus zeae Walsh.

SCOLYTIDAE

Dendroctonus valens Lec.

STATION IX

The sand-dunes, beach ponds, scattered vegetation, and sedges made up this station. Sweet-gale growing in certain localities did not produce a single beetle; none was observed on its foliage, although it sheltered many flies. An immense number of tiger beetles make the dune area their habitat. The sand is rather firm and allows to move about many beetles that are unable to do so on the fine loose sand just back of the beach line. Quite a number of dead specimens were observed on the sand among the sedges.

CICINDELIDAE

Cicindela vulgaris Say.
repanda Dej.
hirticollis Say.

CARABIDAE

Nebria suturalis Lec.
sahlbergi Fisch.
Nomius pygmaeus Dej.
Amara avida Say.
angustata Say.
basillaris Say.
chalcea Dej.
Platynus reflexus Lec.
extensicollis Say.
Lebia atriventris Say.
Harpalus innocuus Lec.
Anisodactylus sericeus Harr.

DYTISCIDAE

Ilybius pleuriticus Lec.
Agabus punctulatus Aube.

SILPHIDAE

Necrophorus marginatus Fab.
vespilloides Herbst.
Silpha surinamensis Fab.

COCCINELLIDAE

Hippodamia 5-signata Kirby.
13-punctata L.
Psyllobora 20-maculata Say.
Hyperaspis bigeminata Rand.

NITIDULIDAE

Nitidula rufipes L.

ELATERIDAE

Elater manipularis Cand.
Agriotes limosus Lec.
Melanotus decumanus Er.
Limonius confusus Lec.
Corymbites cruciatus L.

BUPRESTIDAE

Buprestis fasciata Fab.
fasciata Fab.
sulcicollis Lec.
Agrilus politus Say.

LAMPYRIDAE

Telophorus carolinus Fab.
nigritulus Lec.

SCARABAEIDAE

Trox foveicollis Harr.
Hoplia barbata Blatchley.
Lachnosterna dubia Smith.
gibbosa Burm.
marginalis Lec.
crenulata Froh.
Strigoderma arboricola Fab.
Osmoderma scabra Beauv.

CERAMBYCIDAE

Saperda moesta Lec.

CHRYSOMELIDAE

Donacia hypoleuca Lec.
Orsodacna atra *var.* childreni Kirby.

Cryptocephalus 4-maculata *var.* notatus Fab.
venustus *var.* hamatus Melsh.
Pachybrachys infaustus Hald.
Adoxus vitis L.
Calligrapha elegans Oliv.
Lina obsoleta Say.
scripta Fab.
interrupta Fab.
Cerotoma trifurcata Forst.
Luperus varicornis Lec.
Adimonia 6-vittata Lec.
Oedionychis gibbitarsis Say.
Trirhabda tomentosa L.
brevicollis Lec.
Disonycha quinquevittata Say.
pennsylvanica Ill.

MELANDRYIDAE

Serropalpus barbatus Schall.

OTIORHYNCHIDAE

Otiorhynchus ovatus L.

CURCULIONIDAE

Sitona hispidula Fab.
Phytonomus nigrirostris Fab.
Lepyrus geminatus Fab.
Listronotus squamiger Say.
Lixus rubellus Rand.
Dorytomus laticollis Lec.
brevicollis Lec.
Magdalis pallida Say.
Acalyptus carpini Herbst.
Elleschus ephippiatus Say.

CALANDRIDAE

Sphenophorus melanocephalus Fab.
placidus Say.
Rhyncholus brunneus Mann.

STATION IXa

This station consisted principally of large piles of spruce and firewood at the foot of the large sand-dune or banks running parallel with the shore. Quite a number of the beetles listed for the station may be said to have been found occurring in their proper habitat, as they were found boring and laying their eggs on the logs.

CARABIDAE

Myas cyanescens Dej.

STAPHYLINIDAE

Staphylinus fossator Grav.

ELATERIDAE

Anthous discalceatum Say.

BUPRESTIDAE

Dicera divaricata Say.
spreta Gory.
tenebrosa Kirby.
tuberculata Chev.
Poëcilonota cyanipes Say.
Buprestis lineata Fab.
nuttallii Kirby.
maculiventris Say.
fasciata Fab.
Chrysobothris femorata Fab.
floricola Gory.
dentipes Germ.
blanchardi Horn.
trinervia Kirby.

SCARABAEIDAE

Osmoderma scabra Beauv.

CERAMBYCIDAE

Criocephalus agrestis Kirby.
Calloides nobilis Say.

Arhopalus fulminans Fab.
Xylotrechus undulatus Say.
Rhagium lineatum Oliv.
Acmaeops proteus Kirby.
Bellamira scalaris Say.
Leptura nigrella Say.
  nigrella Say, light form.
  canadensis Fab.
  proxima Say.
  vittata Germ.
Monohammus scutellatus Say.
Pogonocherus mixtus Hald.

STATION X

This station consisted of the sand-dunes running parallel with the shore and covered with trees, shrubs, and various flowering plants. It was not very prolific in insect life, although examined thoroughly in the usual manner.

CARABIDAE

Lebia viridis Say.
Harpalus laticeps Lec.

STAPHYLINIDAE

Aleochara lata Grav.

ELATERIDAE

Drasterius elegans Fab.
Ludius abruptus Say.
Corymbites cruciatus L.

BUPRESTIDAE

Poecilonata cyanipes Say.
Buprestis sulcicollis Lec.
Agrilus anxius Gory.
  politus Say.
  otiosus *var.* defectus Lec.

CLERIDAE

Enoclerus *var.* near dubius Spin.
  muttkowskii Wolcott.

SCARABAEIDAE

Macrodactylus subspinosus Fab.

CHRYSOMELIDAE

Chrysochus auratus Fab.
Oedionychis vians Ill.
Haltica punctipennis Lec.
Chelymorpha argus Licht.

MORDELLIDAE

Anaspis rufa Say.
Mordella scutellaris Fab.
  marginata Melsh.
Mordellisterna biplagiata Helm.
  comata Lec.

CURCULIONIDAE

Conotrachelus nenuphar Herbst.
  posticatus Boh.

SCOLYTIDAE

Dryococtes septentrionis Mann.

STATION XI

This station was a forest road running parallel with the shore at some little distance from it. At some places, sphagnum moss ran out to the road; at others, it was shaded by maple, oak, and spruce. The moss was turned up and sifted, the trees and shrubs were examined, and the road was watched for various beetles.

In addition to the species whose names follow, two undetermined species of Elateridae were taken.

CICINDELIDAE

Cicindela longilabris Say.
vulgaris Say.
repanda Dej.
hirticollis Say.

CARABIDAE

Cychrus lecontei Dej.
Carabus sylvosus Say.
Notiophilus semistriatus Say.
Myas cyanescens Dej.
Platynus tenuicollis Lec.
Chlaenius pennsylvanicus Say.
Bradycellus rupestris Say.

SILPHIDAE

Necrophorus orbicollis Say.
Silpha surinamensis Fab.

STAPHYLINIDAE

Creophilus villosus Grav.
Staphylinus maculosus Grav.
Philonthus furvus Nord.
debilis Grav.
Boletobius anticus Horn.

COCCINELLIDAE

Hippodamia convergens Guer.
Anatis 15-punctata *var.* mali Say.
Chilocorus bivulnerus Muls.
Brachyacantha ursina Fab.

NITIDULIDAE

Nitidula rufipes L.

BYRRHIDAE

Cytilus trivittatus Forst.
Byrrhus americanus Lec.

DASCYLLIDAE

Cyphon variabilis Thunb.

ELATERIDAE

Elater pullus Germ.
apicatus Say.
Megapenthes rogersii Horn.
Ludius hepaticus Germ.
Agriotes stabilis Lec.
luminosus Lec.
Athous cucullatus Say.
Corymbites insidiosus Lec.
propola Lec.
hieroglyphicus Say.
aeripennis Kirby.

BUPRESTIDAE

Buprestis fasciata Fab.
Chrysobothris floricola Gory.
dentipes Germ.
Agrilus torquatus Lec.
Brachys aerosa Melsh.

LAMPYRIDAE

Celetes basalis Lec.
Photuris pennsylvanica DeG.

CLERIDAE

Trichodes nuttalli Kirby.

PTINIDAE

Ptilinus ruficornis Say.

SCARABAEIDAE

Aphodius hammatus Say.
fimetarius L.
ruricola Melsh.
Dichelonycha albicollis Burm.
Serica fimbriata Lec.
Diplotaxis tristis Kirby.

CERAMBYCIDAE

Tragosoma harrisii Lec.
Physocnemum brevilineum Say.
Elaphidion villosum Fab.
Calloides nobilis Say.
Neoclytus muricatulus Kirby.

Leptura nigrella Say, light form.
Monohammus scutellatus Say.

CHRYSOMELIDAE

Syneta ferruginea Germ.
Calligrapha scalaris Lec.
Crepidodera helxines L.
Chalepus rubra Weber.

RHYNCHITIDAE

Eugnamptus collaris Fab.

OTIORHYNCHIDAE

Otiorhynchus ovatus L.

CURCULIONIDAE

Phytonomus nigrirostris Fab.
Desmoris constrictus Say.
Listronotus latiusculus Boh.
frontalis Lec.
Magdalis perforata Horn.
olyra Herbst.
hispoides Lec.
austera *var.* substriata Fall.
Anthonomus signatus Say.
crataegi Walsh.
Rhinoncus pyrrhopus Boh.

CALANDRIDAE

Sphenophorus pertinax Oliv.
zeae Walsh.

SCOLYTIDAE

Dendroctonus valens Lec.

ANTHRIBIDAE

Allandrus bifasciatus Lec.

STATION XII

This station was the area about the post-office, which had been more or less cleared for years, except southwest of the buildings where there were woodpiles, a sandy area, and a jack pine grove. Stumps cut the winter before were set with chip traps. Bottle traps produced very little.

In addition to the following determined species, a few undetermined specimens were taken: four specimens of Phalacrus sp. ? (Phalacridae), Ludius sp. ?, Elater sp. ?, Cryptohypnus sp. ?, and Megapenthes sp. ? (near *stigmosus* Lec.) (Elateridae), Callimoxys sp. ? (Cerambycidae).

CICINDELIDAE

Cicindela hirticollis Say.

CARABIDAE

Carabus serratus Say.
Notiophilus semistriatus S
Bembidium littorale Oliv.
musicola Hayward.
variegatum Say.
sulcatum Lec.
Patrobus longicornis Say.
Pterostichus stygicus Say.
luctuosus Dej.
Amara arenaria Lec.
impuncticollis Say.
cupreolata Putz.
polita Lec.
chalcea Dej.
subaenea Lec.
Diplochila laticollis Lec.
impressicollis Dej.
impressicollis *var.* alternans Casey.

Badister reflexus Lec.
Calathus gregarius Say.
Platynus tenuicollis Lec.
sinuatus Dej.
atratus Lec.
affinis Kirby.
cupripennis Say.
nutans Say.
crenistriatus Lec.
rubripes Zimm.
sordens Kirby.
retractus Lec.
Callida punctata Lec.
Cymindis cribricollis Dej.
Harpalus viridiaeneus Beauv.
pennsylvanicus DeG.
pennsylvanicus *var.* longior Kirby.
Acupalpus carus Lec.
Anisodactylus sayi Blatchley.

SILPHIDAE

Necrophorus vespilloides Herbst.
Silpha surinamensis Fab.
noveboracensis Forst.
Anisotoma valida Horn.
Liodes globosa Lec.

STAPHYLINIDAE

Philonthus politus L.
fusiformis Melsh.
Stenus flavicornis Er.
Conosoma littoreum Kirby.
knoxii Lec.
Bolitobius cincticollis Say.

COCCINELLIDAE

Anisosticta strigata Thunb.
Hippodamia 5-signata Kirby.
convergens Guer.
parenthesis Say.
13-punctata L.
Coccinella sanguinea L.
Anisocalvia 14-guttata *var.* (approaching victoriana Casey).
Anatis 15-punctata *var.* mali Say.

ENDOMYCHIDAE

Phymaphora pulchella Newm.

CUCUJIDAE

Silvanus bidentatus Fab.
Laemophlaeus biguttatus Say.

CRYPTOPHAGIDAE

Atomaria ephippiata Zimm.

MYCETOPHAGIDAE

Mycetophagus pluripunctatus Lec.
Litargus sexpunctatus Say.

DERMESTIDAE

Dermestes lardarius L.
Anthrenus musaeorum L.

HISTERIDAE

Hister merdarius Hoffm.
interruptus Beauv.
depurator Say.
lecontei Mars.

NITIDULIDAE

Carpophilus decipiens Horn. (?)
brachypterus Say.
Conotelus obscurus Er.
Nitidula rufipes L.
ziczac Say.
Rhizophagus brunneus Harr.

LATRIDIIDAE

Melanopthalma distinguenda Com.

TROGOSITIDAE

Tenebrioides americana Kirby.
Peltis ferruginea L.

ELATERIDAE

Cryptohypnus abbreviatus Say.
bicolor Esch.
Monocepidius auritus Herbst.
Elater manipularis Card.
pedalis Germ.
linteus Say.
rubricus Say.
areolatus Say.

Agriotes mancus Say.
stabilis Lec.
fuscosus Lec.
pubescens Melsh.
Melanotus castanipes Payk.
glandicolor Melsh.
communis Gyll.
Athous scapularis Say.
Sericosomus viridanus Say.
Microrhagus pectinatus Lec.

BUPRESTIDAE

Chalcophora verginiensis *var.* lacustris Lec.
Dicerca obscura *var.* lurida Fab.
Poecilonota cyanipes Say.
Buprestis lineata Fab.
Brachys ovata Web.
aerosa Melsh.

LAMPYRIDAE

Celetes basalis Lec.
Eros humeralis Fab.
Telophorus fraxini Say.
Podabrus tomentosus Say.

CLERIDAE

Thanasimus dubius Fab.
undulatus Say.

CIOIDAE

Cis fuscipes Mellie.

LUCANIDAE

Lucanus placidus Say.
Platycerus depressus Lec.
Ceruchus piceus Web.

SCARABAEIDAE

Aphodius fimetarius L.
foetidus Fab.
Trox unistriatus Beauv.
Hoplia barbata Blatchley.
trifaciata Say.
Dichelonycha albicollis Burm.
Diplotaxis sordida Say.
Lachnosterna fusca Froh.
rugosa Melsh.
gibbosa Burm.
Trichius piger Fab.

CERAMBYCIDAE

Physocnemum brevilineum Say.
Elaphidion villosum Fab.
Neoclytus muricatulus Kirby.
Rhagium lineatum Oliv.
Pachyta monticola Rand.
Acmaeops proteus Kirby.
Leptura americana Hald.
biforis Newm.
tibialis Lec.
pubera Say.
Saperda candida Fab.

CHRYSOMELIDAE

Lema trilineata Oliv.
Chalamys plicata Fab.
Pachybrachys autolycus *var.* difficilis Fall.
Colaspis brunnea Fab.
Leptinotarsa 10-lineata Say.
Diabrotica 12-punctata Oliv.
Galerucella marginella Kirby.
Haltica cuprascens Blatchley.

BRUCHIDAE

Bruchus mimus Say.

TENEBRIONIDAE

Nyctobates pennsylvanica DeG.
Xylopinus saperdioides Oliv.
Diaperis maculata Oliv.

MELANDRYIDAE

Scotochroa basalis Lec.
Dircaea liturata Lec.

PYTHIDAE

Crymodes discicollis Lec.
Pytho depressus L.
Salpingus alternatus Lec.

MORDELLIDAE

Mordella scutellaris Fab.

ANTHICIDAE

Notoxus bifasciatus Lec.
Formicomus mundus Lec.
Anthicus floralis L.
coracinus Lec.

MELOIDAE

Macrobasis unicolor Kirby.

CURCULIONIDAE

Sitona tibialis Herbst.
Phytonomus nigrirostris Fab.
Pissodes strobi Peck.
Hylobius confusus Kirby.
Anthonomus rufipes Lec.

BRENTHIDAE

Eupsalis minuta Drury

SCOLYTIDAE

Ips calligraphus Germ.
Hylurgops pinifex Fitch.

STATION XIII

The barnyard was considered the next station since conditions were somewhat different from the previous station, but not many species appeared.

CARABIDAE

Loricera caerulescens L.
Notiophilus semistriatus Say.
Dyschirius setosus Lec.
Pterostichus mutus Say.
Amara exarata Dej.
apricarius Payk. (?)
Platynus cupreus Dej.
Cymindis cribicollis Dej.
Chlaenius nemoralis Say.
Harpalus pennsylvanicus DeG.
herbivagus Say.
Anisodactylus baltimorensis Say.

SILPHIDAE

Choleva clavicornis Lec.

STAPHYLINIDAE

Aleochara lata Grav.
Quedius peregrinus Grav.
desertus Horn.
Philonthus politus L.
Boletobius anticus Horn.

CLERIDAE

Necrobia violaceus L.

SCARABAEIDAE

Aphodius hamatus Say.
ruricola Melsh.

STATION XIV

This station was a small sawmill, with a small grassy area with scattered slabs, boards, and woodpiles. The site ran down to a pond with short stretches of sand or mud shores or flats near its mouth where it drained into Lake Superior. The foliage of small shrubs and willows was examined, as well as the ground-cover.

CARABIDAE

Bembidium simplex Lec.
lucidum Lec.
patruele Dej.
postfasciatum Hamilton.
affine Say.

Pterostichus permundus Say.
sayi Bruelle.
mutus Say.
Platynus decens Say.
anchomenoides Rand.
errans *var.* subcordatus Lec.
Harpalus herbivagus Say.
Stenolophus conjunctus Say.

HYDROPHILIDAE

Cercyon anale Payk.

STAPHYLINIDAE

Philonthus fusiformis Melsh.

COCCINELLIDAE

Hippodamia parenthesis Say.

DASCYLLIDAE

Cyphon variabilis Thunb.

ELATERIDAE

Limonius aeger Lec.

LAMPYRIDAE

Telephorus vilis Lec.

SCARABAEIDAE

Trox foveicollis Harr.

CHRYSOMELIDAE

Cryptocephalus quadruplex Newm.
Colaspis brunnea Fab.
Prasocuris vittata Oliv.
Calligrapha multipunctata *var.* bigsbyanna Kirby.

ANTHICIDAE

Notoxus anchora Hentz.

MELOIDAE

Epicauta trichrus Pall.

STATION XV

This station consisted of the vegetation and mud shores of the pond extension which ran back for about a mile. The sedges and other water plants were denser here than at Station XIV, and merged into marsh and marsh vegetation.

Two undetermined specimens of Cercyon (Hydrophilidae) were taken at this station.

CICINDELIDAE

Cicindela hirticollis Say.

CARABIDAE

Elaphrus ruscarius Say.
Dyschirus sphaericollis Say.
Bembidium nitidum Kirby.
versicolor Lec.
postfasciatum Hamilton.
picipes Kirby.
ustulatum L.
quadrimaculatum L.
Platynus nutans Say.
Dromius piceus Dej.
Miscodera arctica Payk.
Chlaenius sericeus Forst.
Lachnocrepis parallelus Say.
Bradycellus cognatus Gyll.

HALIPLIDAE

Haliplus longulus Lec.
Cnemidotus edentulus Lec.

DYTISCIDAE

Deronectes griseostriatus DeG.

GYRINIDAE

Gyrinus limbatus Say.

HYDROPHILIDAE

Hydrocharis obtusatus Say.
Berosus infuscatus Lec.
striatus Say.
Hydrocombus fimbriatus Melsh.
Creniphilus subcupreus Say.
Cercyon anale Payk.

STAPHYLINIDAE

Quedius fulgidus Fab.
Stilicus angularis Er.
Paederus littorarius Grav.

COCCINELLIDAE

Coccinella trifasciata L.

ELATERIDAE

Corymbites inflatus Say.
Melanotus glandicolor Melsh.
Limonius aurifer Lec.
Nothodes dubitans Lec.

LAMPYRIDAE

Eros thoracicus Rand.
Calochromus perfacetus Say.

PTINIDAE

Hadrobregmus errans Melsh.

CHRYSOMELIDAE

Orsodachna atra *var.* childreni Kirby.
Calligrapha elegans Oliv.

CURCULIONIDAE

Hyperodes solatus Boh.
Orchestes niger Horn.
Mononychus vulpeculus Fab.

CALANDRIDAE

Sphenophorus aequalis Gyll.

STATION XVI

The water and water plants of the pond from Station XIV to Station XV made Station XVI. The pond and different localities were dredged, the muddy water near shore was examined, and the water plants were thoroughly searched for specimens. The water-lilies produced a number of species of Donacia, as did likewise the rushes and sedges growing out in the water.

Two specimens of one undetermined species of Hydroporus (Hydrophilidae) were taken in this station.

HALIPLIDAE

Haliplus cribarius Lec.
ruficollis DeG.

DYTISCIDAE

Deronectes griseostriatus DeG.
brevis Sturm.
Hydroporus undulatus Say.
niger Say.
modestus Aube.
dentellus Fall.
Ilybius biguttalus Germ.
confusus Aube.
Coptotomus interrogatus Fab.
Ilybiosoma bifarius Kirby.
Agabus punctatus Melsh.
subfuscatus Sharpe.
infuscatus Aube.
confinis Gyll.
Rhantus binotatus Harr.
bistriatus Bergst.
Dytiscus harrisii Kirby.

GYRINIDAE

Gyrinus confinis Lec.
picipes Aube.
Dineutes assimilis Aube.

HYDROPHILIDAE

Helophorus nitidulus Lec.
lineatus Say.
tuberculatus Gyll.
Tropisternus mixtus Lec.
glaber Herbst.
sublaevis Lec.
Philhydrus fucatus Horn.
perplexus Lec.
Cryptopleurum minutum Fab.

CHRYSOMELIDAE

Donacia piscatrix Lec.
hirticollis Kirby.
proxima Kirby.
subtilis Kunze.
megacornis Blatchley.
rugosa Lec.
emarginata Kirby.

STATION XVII

The shore of Whitefish Bay constituted Station XVII. It was examined a number of times both in 1913 and in 1914, but even when a considerable sea was running in, the waves produced very little. This may be accounted for by the fact that when the wind was blowing off shore, it was usually a cold northwest wind during which the insects would not be moving about and, hence, would not be blown out over the water of the bay. When the wind was southeast, the insects would move inland from the shore. Some species, however, were found that did not occur at the other stations.

CARABIDAE

Omophron americanus Dej.
Calosoma frigidum Kirby.
Elaphrus riparius L.
Bembidium transversale DeG.
anguliferum Lec.
Pterostichus luczotii Dej.
erythropus Dej.
Amara exarata Dej.
Platynus extensicollis Say.
anchomenoides Rand.
pusillus Lec.
pusillus Lec., color var.
moerens Dej.
Dromius piceus Dej.
Harpalus pennsylvanicus *var.* longior Kirby.

DYTISCIDAE

Hydroporus niger Say.
Agabus punctatus Melsh.

GYRINIDAE

Gyrinus ventralis Kirby.
lugens Lec.

SILPHIDAE

Necrophorus orbicollis Say.
tomentosus Web.
Silpha lapponica Herbst.

STAPHYLINIDAE

Xantholinus obscurus Er.
Tachinus menonius Grav.
fimbriatus Grav.
Tachyporus chrysomelinus L.

BYRRHIDAE

Byrrhus murinus Fab.

ELATERIDAE

Elater mixtus Herbst.

Corymbites sulcicollis Say.
insidiosus Lec.

BUPRESTIDAE

Dicerca divaricata Say.
lurida Fab.
Buprestis nuttallii *var.* consularis Gory.
striata *var.* impedita Say.
Melanophila longipes Say.
fulvoguttata Harr.
Chrysobothris floricola Gory.
Agrilus acutipennis Mann.
bilineatus Web.

PTINIDAE

Hadrobregmus errans Melsh.

SCARABAEIDAE

Onthophagus hecate Panz.
Aphodius ruricola Melsh.
granarius L.
Serica vespertina Gyll.
Osmoderma scabra Beauv.

CERAMBYCIDAE

Clytanthus ruricola Oliv.
Leptura nigrella Say, light form.
americana Hald.
Saperda vestita Say.
tridentata Oliv.

CHRYSOMELIDAE

Bassareus formosus *var.* sulphuripennis Melsh.
Diabrotica 12-punctata Oliv.
Trirhabda flavolimbata Mann.
Haltica chalybea Ill.
Chalepus nervosa Panz.

TENEBRIONIDAE

Iphthimus opacus Lec.
Upis ceramboides L.
Tenebrio obscurus Fab.

MELANDRYIDAE

Serropalpus barbatus Schall.

ANTHICIDAE

Malporus cinctus Say.
Sapintus fulvipes Laf.

CURCULIONIDAE

Hylobius confusus Kirby.

CALANDRIDAE

Sphenophorus zeae Walsh.

STATION XVIII

This station was an open woods east of the post-office. The trees were large and mostly hardwood and gave very few beetles. The season was too early for fungi, but it is probable that after the middle of August many fungus beetles could be found here.

CARABIDAE

Omophron tessellatum Say.
Tachys incurvus Say.
Calanthus opaculus Lec.
Platynus sinuatus Dej.
pusillus Lec.
picipennis Kirby.
Agonderus partiarius Say.
Anisodactylus harrisii Lec.

STAPHYLINIDAE

Philonthus debilis Grav.
cyanipennis Fab.
Tachinus scrutator Horn.
Boletobius anticus Horn.

MYCETOPHAGIDAE

Mycetophagus flexuosus Say.

NITIDULIDAE

Nitidula rufipes L.
Omosita colon L.
Ips fasciatus Oliv.

TROGOSITIDAE

Peltis ferruginea L.

BYRRHIDAE

Byrrhus americanus Lec.

BUPRESTIDAE

Melanophila fulvoguttata Harr.
Agrilus politus Say.

SCARABAEIDAE

Geotrupes egeriei Germ.

CERAMBYCIDAE

Orthosoma brunneum Forst.
Pachyta rugipennis Newm.

ANTHICIDAE

Anthicus melancholicus Laf.

SCOLYTIDAE

Tomicus (Ips) pini Say.
interruptus Mann.
Dendroctonus terebrans Oliv.

STATION XIX

This station was a trail running in a southeasterly direction from the post-office to Whitefish Bay. It ran for most of its length along the ridges, crossing the point in a southeasterly direction. It was fairly well wooded with small maples, oaks, yellow and paper birch, and considerable shrubbery at each side. There were several small marshy places along it. The station was examined by sifting, beating, and using the sweep-net.

CICINDELIDAE

Cicindela longilabris Say.
vulgaris Say.

CARABIDAE

Carabus serratus Say.
Calosoma scrutator Fab.
Pterostichus lucublandus Say.
Diplochila laticollis Lec.
Chlaenius pennsylvanicus Say.
Harpalus laticeps Lec.
innocuus Lec.
Anisodactylus rusticus Say.

DYTISCIDAE

Agabus punctulatus Aube.

STAPHYLINIDAE

Philonthus blandus Grav.
Stenus flavicornis Er.
Tachinus scrutator Horn.
Oxyporus femoralis Grav.

SCAPHIDIIDAE

Baeocera concolor Fab.

PHALACRIDAE

Eustilibus apicalis Melsh.

NITIDULIDAE

Rhizophagus brunneus Horn.

ELATERIDAE

Tharops ruficornis Say.
Cardiophorus convexulus Lec.
Ludius hepaticus Germ.
Melanotus castanipes Payk.
Cardiophorus convexulus Lec.
Athous brightwelli Kirby.
Corymbites spinosus Lec.

LAMPYRIDAE

Plateros modestus Say.
Eros crenatus Germ.
Photinus pyralis L.

SCARABAEIDAE

Aphodius hamatus Say.
vittatus Say.
Geotrupes blackburnii Fab.
balyi Jck.
Dichelonycha elongata Fab.
fuscula Lec.
Serica sericea Ill.
Lachnosterna rugosa Melsh.
Trichius affinis Gory.

CERAMBYCIDAE

Xylotrechus colonus Fab.
Desmocerus palliatus Forst.

CHRYSOMELIDAE

Adoxus vitis L.
Calligrapha scalaris Lec.
Gastroidea polygoni L.
Lina obsoleta Say.
Disonycha quinquevittata Say.
Chelymorpha argus Licht.

TENEBRIONIDAE

Boletotherus bifurcus Fab.

MELANDRYIDAE

Hallomenus debiles Lec.

CALANDRIDAE

Rhodobaenus tredecimpunctatus Ill.

LIST OF SPECIES

(Numbers following names of species refer to station numbers.)

CICINDELIDAE

1. Cicindela longilabris Say. VII: two specimens, on sand. XI: four specimens, flying along road; others observed. XIX: four specimens, on sandy trail.
2. Cicindela patruela Dej. VII: one on sandy area.
3. Cicindela purpurea var. limbalis Kl. VII: one specimen, on sandy area, no others seen.
4. Cicindela vulgaris Say. IX: two specimens, others seen on low sand-dunes; does not appear to mix with *C. hirticollis*. XI: two specimens, on sandy road. XIX: two specimens on sandy road.
5. Cicindela repanda Dej. VIII: several specimens, on lake shore, sandy beach. IX: several specimens on moist shore of pool of water in sand-dunes. XI: one specimen, on road, uncommon.

6. CICINDELA HIRTICOLLIS Say. IX: one specimen "typical form;" several others observed; six specimens with varying marks, some almost obliterated, others approaching the "typical form." XI: several specimens, on sandy road. XII: several specimens, others seen, nearly immaculate. XV: several specimens running about sandy mouth of small creek draining into pond.
7. CICINDELA HIRTICOLLIS var. RHODENSIS Calder. (?) VII: two specimens, on sandy area, no others seen.

CARABIDAE

8. OMOPHRON AMERICANUM Dej. II: several specimens under debris on sandy beach of lake. XVII: two specimens, under debris, shore of small creek running into Whitefish Bay.
9. OMOPHRON TESSELLATUM Say. XVII: one specimen, under log.
10. CYCHRUS LECONTEI Dej. XI: one specimen, under sphagnum moss at base of tree; only specimen found.
11. CARABUS MAEANDER Fisch. VII: one specimen, under leaves at base of white cherry.
12. CARABUS SYLVOSUS Say. XI: one specimen, under leaves at side of log near road.
13. CARABUS SERRATUS Say. XII: one specimen, under board, near post-office; a second specimen, under board, near schoolhouse. XIX: one specimen, under board on trail.
14. CALOSOMA SCRUTATOR Fab. VIII: two or three specimens, hiding under debris on shore; a few dead and battered specimens in wash-up; again, several very active specimens running about and under debris on shore, also a number of dead and water-worn specimens scattered along the shore. XIX: three specimens, found by beating branches along beach trail.
15. CALOSOMA FRIGIDUM Kirby. II: three specimens, from debris on sandy beach of lake. VII: two specimens, climbing branches of wild cherry trees searching for caterpillars.

VIII: two specimens, under board on damp sand of shore. XVII: one specimen, running on shore of Whitefish Bay.

16. Calosoma calidum Fab. VIII: several specimens, very active in debris on lake shore.
17. Elaphrus clairvillei Kirby. II: one specimen, on muddy beach of lake.
18. Elaphrus laevigatus Lec. II: two specimens, running on muddy beach of lake.
19. Elaphrus riparius L. XVII: several specimens, on mud, shore of creek.
20. Elaphrus fuliginosus Say. II: one specimen, on muddy shore of lake.
21. Elaphrus ruscarius Say. II: one specimen, on muddy shore of lake. XV: two specimens, on mud shore of pond.
22. Blethisa quadricollis Hald. VIII: one specimen without head or thorax, in wash-up; one specimen, under debris; remains of another observed.
23. Loricera caerulescens L. XIII: one specimen, under board in barnyard.
24. Notiophilus semistriatus Say. VIII: one specimen, under board on damp sand near water. XI: two specimens, under damp moss thrown in road as bait. XII: one specimen, under damp hay and leaves, side of road near post-office. XIII: one specimen, under old straw.
25. Nebria suturalis Lec. IX: one specimen, under debris on shore of creek draining Weatherhog Lake and crossing sand-dunes to Lake Superior.
26. Nebria sahlbergi Fisch. IX: one specimen, under debris as above.
27. Dyschirius longulus Lec. VI: one specimen, under sphagnum moss.
28. Dyschirius sellatus Lec. XI: one specimen, on pine log.
29. Dyschirius brevipennis Lec. IV: one specimen, under damp leaves at base of stump.
30. Dyschirius setosus Lec. VIII: one specimen, underside of board on damp sand. XIII: one specimen, from wet hay in barnyard.

31. DYSCHIRIUS SPHAERICOLLIS Say. II: one specimen, on muddy shore of lake. XV: one specimen, on mud flat, edge of pond.
32. CLIVINA DENTIPES Dej. VIII: one specimen, in debris on damp sand.
33. CLIVINA IMPRESSIFRONS Lec. VIII: two specimens, debris on damp sand.
34. NOMIUS PYGMAEUS Dej. IX: one specimen, on sand.
35. BEMBIDIUM CARINULA Cha. VIII: one specimen, running on damp sand.
36. BEMBIDIUM LITTORALE Oliv. IXa.; XII: four specimens, on sand-slide of shore bank; many more observed, very active, near post-office.
37. BEMBIDIUM INAEQUALE Say. VIII: one specimen, running on damp sand.
38. BEMBIDIUM CONFUSUM Hay. VIII: one specimen, under debris; two specimens, under debris on wet sand.
39. BEMBIDIUM NITIDUM Kirby. XV: two specimens, on mud shore.
40. BEMBIDIUM USTULATUM L. II: three specimens, running on muddy shore of lake. XV: two specimens, on mud, edge of pond.
41. BEMBIDIUM SIMPLEX Lec. XIV: one specimen, under debris, shore of pond near post-office.
42. BEMBIDIUM MUSICOLA Hay. II: one specimen, running on wet surface of mud shore. XII: five specimens, under damp leaves at base of stump.
43. BEMBIDIUM CHALCEUM Dej. XVI: one specimen, found under chip.
44. BEMBIDIUM TRANSVERSALE Dej. XVII: two specimens, under debris on shore of bay.
45. BEMBIDIUM LUCIDUM Lec. XIV: two specimens, under debris on shore of pond.
46. BEMBIDIUM FUSCICRUM Mots. VIII: one specimen, running about debris; a second in debris.
47. BEMBIDIUM PICIPES Kirby. XV: one specimen, under chip on shore of stream running into pond.

48. Bembidium scopulinum Lec. II: two specimens, under chips on mud shore of lake.
49. Bembidium fraternum Lec. II: three specimens, under chips.
50. Bembidium patruele Dej. XIV: one specimen, under debris on shore.
51. Bembidium variegatum Say. XII: one specimen, under leaves near post-office.
52. Bembidium versicolor Lec. II: five specimens, running on muddy shore of lake.
53. Bembidium postfasciatum Hamilton. XV: one specimen, on mud shore.
54. Bembidium sulcatum Lec. II: one specimen, on mud shore of lake. XII: three specimens, under damp leaves at base of stump.
55. Bembidium affine Say. XIV: two specimens, running on muddy shore of pond.
56. Bembidium anguliferum Lec. II: one specimen, on mud shore of lake. XVII: two specimens, under debris.
57. Bembidium quadrimaculatum L. XV: two specimens, under leaves near edge of pond.
58. Tachys flavicauda Say. IV: one specimen, under damp leaves at base of stump.
59. Tachys nanus Gyll. IV: one specimen, under bark of dead birch on ridge.
60. Tachys incurvus Say. VII: three specimens, in ants' nest, sandy area; no others observed. XVIII: one specimen, under leaves at base of stump.
61. Patrobus longicornis Say. II: eight specimens, under logs on sandy shore of lake. VIII: two specimens, under board on damp sand. XII: four specimens, under boards near edge of cranberry marsh.
62. Myas cyanescens Dej. IXa: two specimens, crawling at foot of sand-dune. XI; one specimen, under board by side of road.
63. Pterostichus adoxus Say. IV: one specimen, under leaves, base of spruce stump on ridge.

64. Pterostichus honestus Say. VI: one specimen, under log.
65. Pterostichus coracinus Newm. Near lighthouse.
66. Pterostichus stygicus Say. VI: two specimens, under leaves at base of stump. VIII: one specimen, under board on damp sand. XII: one specimen, under board near post-office.
67. Pterostichus relictus Newm. VIII: two specimens, under boards on damp sand.
68. Pterostichus punctatissimus Rand. VIII: one specimen.
69. Pterostichus permundus Say. II: one specimen, under beaver chip on water's edge, lake. VIII: two specimens, under boards on damp sand. XIV: two specimens, under board near sawmill; several others observed.
70. Pterostichus sayi Brulle. XIV: one specimen, under board near sawmill.
71. Pterostichus lucublandus Say. II: two specimens, under logs, sandy shore of lake. XIX: three specimens, under log by side of trail.
72. Pterostichus caudicalis Say. II: three specimens, under log by edge of lake. VIII: one specimen, under debris on damp sand.
73. Pterostichus luctuosus Dej. XII: one specimen, under board.
74. Pterostichus corvinus Dej. II: three found under log. VI: three specimens, under sphagnum moss. VIII: two specimens, under debris.
75. Pterostichus mutus Say. V: four specimens, running from advancing fire; others seen. VIII: two specimens, in wash-up of debris; three specimens, under boards on damp sand. XIII: two specimens, under board. XIV: two specimens, under boards near sawmill.
76. Pterostichus luczotii Dej. VIII: several specimens, under boards; two specimens, under damp debris. XVII: two specimens, under debris.
77. Pterostichus erythropus Dej. VIII: one specimen,

hiding under board; three specimens, under damp debris. XVII: two specimens, under debris.

78. Amara avida Say. IX: three specimens, under board, shore of beach pond. XII: one specimen, under board near post-office.
79. Amara arenaria Lec. XII: one specimen, under board near post-office.
80. Amara rufimanus Kirby. VIII: one specimen, under debris.
81. Amara cylindrica Lec. VIII: one specimen, under debris on shore.
82. Amara elongata Lec. VIII: one specimen, under board.
83. Amara apricarius Payk. VIII: several, under boards.
84. Amara exarata Dej. II: two specimens, under debris on shore of lake. XIII: two specimens, under boards in barnyard. XVII: one specimen, under debris.
85. Amara latior Kirby. VIII: one specimen under debris on shore of Lake Superior.
86. Amara angustata Say. IX: one specimen, under board on sand-dune.
87. Amara impuncticollis Say. XII: one specimen, under board near post-office.
88. Amara basillaris Say. IX: one specimen, under board on dry sand.
89. Amara crassispina Lec. VIII: one specimen, running on sand near edge of water.
90. Amara cupreolata Putz. II: one specimen, under beaver chip on shore of lake. XII: one specimen under board near post-office.
91. Amara fallax Lec. VIII: one specimen, under debris.
92. Amara protensa Putz. VI: two specimens under sphagnum moss. VIII· one specimen under debris.
93. Amara polita Lec. XII: one specimen, under board.
94. Amara erratica Sturm. VIII: two specimens, under debris on lake shore.
95. Amara interstitialis Dej. VIII: four specimens, under board.

96. Amara obesa Say. II: one specimen, under debris on shore of lake.
97. Amara chalcea Dej. IX: two specimens, under debris on sand-dune. XII: several specimens, under board near post-office.
98. Amara remotestriata Dej. II: five specimens, under debris on mud shore of lake. VIII: two specimens, on damp sand near edge of water.
99. Amara gibba Lec. XI: one specimen, under board at side of forest road.
100. Amara rubrica Hald. XI: three specimens, under board at side of forest road.
101. Amara musculus Say. VIII: one specimen, under board.
102. Amara subaenea Lec. XII: one specimen, under board near post-office.
103. Diplochila laticollis Lec. XII: three specimens, under boards near shore of pond at post-office. XIX: one specimen, edge of marshy place near trail.
104. Diplochila impressicollis Dej. XII: two specimens, under boards near pond.
105. Diplochila impressicollis var. alternans Casey. XII: one specimen, under board near pond.
106. Badister pulchellus Lec. VIII: one specimen, running on damp sand of shore.
107. Badister micans Lec. II: one specimen, under log on mud shore of lake.
108. Badister reflexus Lec. II: two specimens, under log on shore of lake. XII: two specimens, under leaves at base of stump.
109. Calathus gregarius Say. VI: six specimens under moss. XII: three specimens, under leaves at base of stumps.
110. Calathus opaculus Lec. VI: three specimens, found under logs. XVIII: three specimens, under logs.
111. Platynus decens Say. VI: two specimens, under sphagnum moss. XIV: two specimens, under board, near sawmill.
112. Platynus sinuatus Dej. VI: one specimen, under

sphagnum moss. XII: one specimen, under bark near post-office.

113. Platynus tenuicollis Lec. XI: three specimens, under leaves at base of maple. XII: two specimens, under log near post-office.

114. Platynus reflexus Lec. IX: one specimen, running on damp sand on shore of beach pond.

115. Platynus brunneomarginatus Mann. VI: two specimens, under log in forest.

116. Platynus extensicollis Say. IX: two specimens, under boards on shore of drying beach pond. XVII: one specimen, from debris.

117. Platynus decorus Say. V: two specimens, running from fire.

118. Platynus anchomenoides Rand. II: two specimens, under debris near edge of lake. VI: six specimens, under sphagnum moss; well distributed under this cover; is the dominant beetle of the forest floor; hundreds observed. XIV: four specimens, under board.

119. Platynus pusillus Lec. II: twelve specimens, under debris on sand shore of beach. XVII: four specimens, under debris and boards. XVIII: four specimens, under leaves at base of stump.

120. Platynus pusillus Lec., color var. XVII: four specimens, in debris.

121. Platynus errans var. subcordatus Lec. XIV: four specimens, running in grass.

122. Platynus moerens Dej. VI: four specimens, under logs and sphagnum moss; fairly common. VIII: two specimens, under damp debris. XVII: two specimens, under board.

123. Platynus tenuis Lec. VI: two specimens, sifting sphagnum moss.

124. Platynus atratus Lec. II: three specimens, under debris by water, edge of lake. VI: one specimen, sifting moss. XII: one specimen, under board near post-office.

125. Platynus melanarius Dej. II: six specimens, hiding under sphagnum moss debris by edge of lake.

126. Platynus affinis Kirby. VI: two specimens, under sphagnum moss. XII: one specimen, under damp leaves at base of stump near post-office.
127. Platynus carbo Lec. VI: two specimens, under leaves by side of log.
128. Platynus cupripennis Say. II: three specimens, under chips on shore of lake. VIII: one specimen, under debris of wash-up. XII: two specimens, under board near post-office; others observed.
129. Platynus ferreus Hald. VIII: one specimen, in wash-up.
130. Platynus octocolus Mann. IV: one specimen, under leaves at base of spruce stump on ridge. VI: two specimens, under leaves.
131. Platynus nutans Say. XII: one specimen, under board near post-office. XV: two specimens, under board near shore.
132. Platynus variolatus Lec. II: one specimen, under board by edge of lake.
133. Platynus cupreus Dej. VIII: one specimen, under board on damp sand. XIII: one specimen, under board.
134. Platynus bogemanni Gyll. II: one specimen, under debris by edge of lake.
135. Platynus quadripunctatus DeG. II: four specimens, under chips. VI: two specimens, under sphagnum moss.
136. Platynus aeruginosus Dej. VIII: several specimens, under debris of wash-up.
137. Platynus limbatus Say. VIII: one specimen, under board; another, under board.
138. Platynus crenistriatus Lec. V: four specimens, running from advancing fire; others noticed. XII: one specimen, under board near post-office.
139. Platynus rubripes Zimm. V: four specimens, captured on edge of burning area; others seen, all were running from the fire.
140. Platynus sordens Kirby. XII: one specimen, under board near post-office.
141. Platynus ruficornis Lec. VIII: two specimens, in damp debris in wash-up; one dead specimen in wash-up.

142. PLATYNUS RETRACTUS Lec. XII: one specimen, under leaves at base of stump near post-office.
143. PLATYNUS GEMELLUS Lec. XI: one specimen, under board at side of forest road.
144. PLATYNUS PICIPENNIS Kirby. VI: one specimen, found by sifting sphagnum moss. XVIII: one specimen, under moss.
145. PLATYNUS LUTULENTUS Lec. XVIII: one specimen, under log.
146. CASNONIA PENNSYLVANICA L. VIII: several specimens; quite a number observed all along the shore-line running about debris on wet sand.
147. GALERITA JANUS Fab. VI: one specimen, under rotten wood. VIII: one water-worn specimen, in wash-up.
148. LEBIA ATRIVENTRIS Say. IX: one specimen, under board in sand-dune.
149. LEBIA TRICOLOR Say. II: one specimen, under board on sandy shore of lake. III: one specimen, on blossoms of spirea.
150. LEBIA VIRIDIS Say. X: two specimens, feeding on blossoms.
151. LEBIA SCAPULARIS Dej. III: one specimen; feeding on spirea blossoms.
152. DROMIUS PICEUS Dej. XV: four specimens, on mud edge of pond. XVII: one specimen, under debris.
153. CALLIDA PUNCTATA Lec. III: one specimen, on spirea blossom. XII: one specimen, on blossom of mountain-ash, near lake shore.
154. CYMINDIS CRIBRICOLLIS Dej. II: two specimens, under log near mud shore of lake. XII: two specimens, under board near post-office. XIII: four specimens, under board.
155. MISCODERA ARCTICA Payk. II: three specimens, under board by edge of lake. XV: one specimen, near edge of pond. Very rare in any locality.
156. CHLAENIUS ERYTHROPUS Germ. II: one specimen, under log near edge of mud shore.
157. CHLAENIUS SERICEUS Forst. II: one specimen, under log by edge of mud shore. XV: two specimens, under board.

158. CHLAENIUS DIFFINIS Chd. II: one specimen, under beaver chip near edge of sand shore.
159. CHLAENIUS NEMORALIS Say. VIII: one worn specimen, in wash-up; three specimens, very active, running under debris. XIII: one specimen, under board.
160. CHLAENIUS PENNSYLVANICUS Say. VIII: one specimen, under board on wet sand. XI: several specimens, under board by side of road.
161. CHLAENIUS NIGER Rand. VIII: one specimen, under debris.
162. CHLAENIUS TOMENTOSUS Say. II: one specimen, under log on mud shore of lake. VIII: one specimen, under debris.
163. BRACHYLOBUS LITHOPHILUS Say. II: one specimen, under damp sphagnum moss by edge of lake.
164. LACHNOCREPIS PARALLELUS Say. XV: one specimen, under weeds by shore of pond.
165. GEOPINUS INCRASSATUS Dej. VIII: one specimen, under board.
166. AGONODERUS PALLIPES Fab. II: two specimens, under damp debris on shore of lake. VIII: two specimens from debris; two specimens from under debris.
167. AGONDERUS PARTIARIUS Say. VIII: one specimen, under debris. XVIII: one specimen, under leaves at base of stump.
168. HARPALUS ERRATICUS Say. II: one specimen, under board by shore of lake. VIII: two specimens, under debris, quite a number of dead specimens in wash-up; one live specimen, in wash-up.
169. HARPALUS VIRIDIAENEUS Beauv. XII: six specimens, under boards, near post-office; common.
170. HARPALUS CALIGINOSUS Fab. VIII: two specimens, running on damp sand at water's edge.
171. HARPALUS PENNSYLVANICUS DeG. VIII: two specimens, in wash-up. XII: two specimens, under board near post-office. XIII: two specimens, under boards.
172. HARPALUS PENNSYLVANICUS var. LONGIOR Kirby. II: three specimens, on mud shore of lake. XVII: two specimens, running on shore.

173. Harpalus pennsylvanicus var. erythropus DeG. II: one specimen, in company with *H. longior* on shore of lake. VIII: one specimen, under board.
174. Harpalus pleuriticus Kirby. VIII: one specimen, under board on moist sand.
175. Harpalus herbivagus Say. III: two specimens, found by sweeping herbage. VIII: three specimens, under boards; three specimens under debris; several dead specimens, in wash-up. XIII: two specimens, under board. XIV: three specimens, on herbage near pond; others observed.
176. Harpalus innocuus Lec. VIII: one specimen, from wash-up. IX: one specimen, under board on sand-dune. XIX: one specimen by side of trail.
177. Harpalus rufimanus Lec. VIII: two specimens, under boards; two specimens, dead, in wash-up.
178. Harpalus laticeps Lec. IV: four specimens, under logs on top of ridge. X: two specimens, under logs on top of sand-dune. XIX: one specimen, under board, on ridge near trail.
179. Harpalus viduus Lec. III: two specimens, under log. VIII: four specimens, under boards; one specimen, under board.
180. Stenolophus conjunctus Say. II: two specimens, in debris on shore of lake. XIV: three specimens, under debris near shore of pond.
181. Stenolophus ochropezus Say. VIII: two specimens, under board.
182. Acupalpus carus Lec. XII: one specimen, under bark of birch near post-office.
183. Bradycellus cognatus Gyll. XV: two specimens, under boards on shore.
184. Bradycellus cordicollis Lec. XIV: one specimen, under board near post-office.
185. Bradycellus rupestris Say. II: two specimens, running on sandy shore of lake. XI: two, under leaves.
186. Anisodactylus rusticus Say. VII: two specimens, under leaves at base of Amelanchier bush. XIX: three specimens, under board by side of trail.

187. Anisodactylus interpunctatus Kirby. VII: nine specimens, under leaves at bases of cherry and pine trees.

188. Anisodactylus agricola Say. V: one specimen, escaping from burning area.

189. Anisodactylus harrisii Lec. V: one specimen, running from fire. XVIII: two specimens, under log.

190. Anisodactylus nigerrimus Dej. VIII: two specimens, under board on shore; four specimens, under debris.

191. Anisodactylus discoideus Dej. II: one specimen, under chips. VIII: one specimen, running on shore of lake.

192. Anisodactylus baltimorensis Say. VI: one specimen from sphagnum moss. VIII: one specimen, on damp sand. XIII: one specimen, under board.

193. Anisodactylus sayi Blatchley. XII: two specimens, under board near post-office.

194. Anisodactylus terminatus Say. VIII: two specimens, under boards in damp sand; two specimens, one dead in wash-up, one under debris near water's edge.

195. Anisodactylus sericeus Harr. VIII: two specimens, under boards on damp sand. IX: three found under boards on sand-dunes.

HALIPLIDAE

196. Haliplus cribrarius Lec. II: two specimens, in wet debris on edge of lake. XVI: two specimens, in weeds dragged from water, edge of pond.

197. Haliplus ruficollis DeG. XVI: one specimen, in weeds dragged from edge of pond.

198. Haliplus longulus Lec. II: one specimen, in water plants by edge of lake. II: one found in water plants. XV: one specimen, in wet weeds by shore.

199. Cnemidotus edentulus Lec. XV: one specimen, in wet debris on shore.

DYTISCIDAE

200. Laccophilus maculosus Germ. I: one specimen, in water plants near edge of pond.

201. Bidessus flavicollis Lec. II: one specimen, in matted water plants at edge of lake.
202. Bidessus fuscatus Cr. II: one specimen, on wet mud on edge of lake.
203. Coelambus impressopunctatus Sch. I: one specimen, found while dredging water plants at edge of pond.
204. Deronectes griseostriatus DeG. XV: one specimen, in wet weeds on shore. XVI: two specimens, in dredging from pond.
205. Deronectes brevis Sturm. XVI: several specimens, in dredging from pond.
206. Hydroporus undulatus Say. I: four specimens, in dredging from near shore of pond. II: two specimens, under debris and in mud on shore of lake. XVI: two specimens, in dredge-net.
207. Hydroporus consimilis Lec. I: three specimens, from muddy water near edge of pond. II: one specimen, under chip at water at edge of lake.
208. Hydroporus tristis Payk. II: seven specimens, in weeds, sedges, and muddy water near edge of lake.
209. Hydroporus niger Say. XVI: one specimen, secured by dredging. XVII: one specimen, at mouth of creek entering Whitefish Bay.
210. Hydroporus modestus Aube. I: one specimen, swimming near surface of water. II: one specimen, under debris near edge of lake. XVI: two specimens in dredging.
211. Hydroporus dentellus Fall. XVI: several specimens, in dredging from pond.
212. Ilybius subaeneus Er. I: two specimens, in dredging. VIII: two specimens, alive in wash-up.
213. Ilybius pleuriticus Lec. VIII: one specimen, crawling on wet sand. IX: one specimen under board by shore of beach pool.
214. Ilybius ignarus Lec. I: one specimen, swimming near surface of pond.
215. Ilybius biguttalus Germ. I: seven specimens, in dredg-

ing from lake. XVI: five specimens, swimming in creek draining pond.

216. Ilybius confusus Aube. I: two specimens, in dredging. XVI: one specimen, swimming in creek; two specimens in pond.

217. Coptotomus interrogatus Fab. I: one specimen, in dredging. XVI: two specimens, in dredging.

218. Ilybiosoma bifarius Kirby. XVI: two specimens, dragged up in debris on shore.

219. Copelatus glyphicus Say. I: one specimen, in dredging.

220. Agabetes acuductus Harr. I: one specimen, in dredging.

221. Agabus punctatus Melsh. XVI: one specimen, in dredging. XVII: one found in wash-up.

222. Agabus obtusatus Say. I: several specimens, in dredging.

223. Agabus semipunctatus Kirby. I: one specimen, in dredging near shore of lake.

224. Agabus punctulatus Aube. II: two specimens, under wet sphagnum moss near edge of lake. VIII: three specimens, in wash-up. IX: two specimens, one swimming in beach pool. XVI: one specimen, in dredging. XIX: six specimens, in pond near trail to Whitefish Bay.

225. Agabus subfuscatus Sharp. VIII: one specimen, under wet debris. XVI: two specimens, in dredging from pond.

226. Agabus infuscatus Aube. XVI: one specimen, in dredging.

227. Agabus confinis Gyll. VIII: one specimen, under wet debris. XVI: one specimen, taken in dredge-net.

228. Agabus obsoletus Lec. I: one specimen, in dredging.

229. Agabus erythropterus Say. VIII: one specimen, under wet debris.

230. Scutopterus angustus Lec. I: several specimens, in dredging from near shore.

231. Rhantus binotatus Harr. VIII: two specimens, crawling up from water edge; others observed. XVI: four specimens, in pond.

232. Rhantus bistriatus Bergst. I: four specimens, in dredged mud and weeds from near shore of lake. II: five

specimens, under sphagnum moss near edge of lake. XVI: three specimens, in dredging.

233. Rhantus tostus Lec. II: two specimens, under sphagnum moss near edge of lake.

234. Colymbetes longulus Lec. VIII: one specimen, alive in wash-up.

235. Colymbetes sculptilis Harr. I: three specimens, in dredging from among roots of water plants. VIII: three specimens, crawling up from water edge.

236. Hydaticus stagnalis Fab. I: one specimen, found by dredging among water plants of lake.

237. Dytiscus fasciventris Say. I: two females, found by dredging water plants.

238. Dytiscus hybridus Aube. VIII: one specimen, dead in wash-up; two specimens crawling up from water.

239. Dytiscus verticalis Say. VIII: one specimen, dead in wash-up.

240. Dytiscus sublimbatus Lec. I: one female, in dredging.

241. Dytiscus dauricus Gebl. I: one specimen, in dredging.

242. Dytiscus harrisii Kirby. I: one specimen, in dredging, VIII: one specimen, crawling up from water of lake. XVI: one specimen, in dredging.

243. Acilius fraternus Harr. I: two specimens, in dredging. VIII: four specimens, three crawling up from water edge, one thrown up on sand by waves.

244. Acilius mediatus Say. I: one specimen, swimming near surface of pond.

245. Graphoderes fasciatocollis Harr. I: four specimens, in dredging. VIII: two specimens, crawling up from water edge.

246. Cybister fimbriolatus Say. VIII: one specimen, dead in wash-up. XVI.

GYRINIDAE

247. Gyrinus confinis Lec. I: three specimens, swimming on surface of lake. XVI: four specimens, on surface of pond; others observed.

248. Gyrinus limbatus Say. XV: one specimen, under wet debris.
249. Gyrinus ventralis Kirby. XVII: one specimen, under wet debris by edge of water on Whitefish Bay.
250. Gyrinus affinis Aube. I: three specimens, swimming on surface of Weatherhog Lake. XVII: one specimen, under debris on shore of Whitefish Bay.
251. Gyrinus lugens Lec. XVII: one specimen, under wet debris with *G. limbalis.*
252. Gyrinus picipes Aube. XVI: three specimens, on surface of pond.
253. Dineutes assimilis Aube. VIII: one specimen, in wash-up. XVI: two specimens, on surface of pond.
254. Dineutes nigrior Roberts. II: two specimens, under sphagnum moss by edge of lake.

HYDROPHILIDAE

255. Helophorus lacustris Lec. I: one specimen, from muddy water near shore.
256. Helophorus nitidulus Lec. I: one specimen, from muddy water near shore. XVI: one specimen, in muddy water, pond near post-office.
257. Helophorus lineatus Say. I: one specimen, muddy water near shore; a second, in dredging from about twenty feet from shore. XVI: one specimen, taken by stirring up water by shore of pond.
258. Helophorus tuberculatus Gyll. XVI: several specimens, in dredging.
259. Hydrophilus triangularis Say. VIII: one specimen, crawling up from edge of water; several dead and battered specimens observed.
260. Hydrophilus nimbatus Say. I: three specimens, in dredging; one specimen, crawling up from edge of water.
261. Tropisternus mixtus Lec. XVI: two specimens, in pond.
262. Tropisternus glaber Herbst. VIII: one specimen, from wash-up. XVI: one specimen, in dredging.

263. Tropisternus sublaevis Lec. VIII: one specimen, crawling up from water's edge. XVI: two specimens, in pond.
264. Hydrocharis obtusatus Say. VI: four specimens, under damp sphagnum moss, apparently getting ready to hibernate. XV: one specimen, under damp debris, edge of pond near post-office.
265. Berosus infuscatus Lec. XV: one specimen, under wet debris by edge of pond.
266. Berosus striatus Say. II: four specimens, in mud and weeds by edge of lake. XV: two specimens, in wet debris on shore.
267. Philhydrus fucatus Horn. I: two specimens, in muddy water. XVI: one specimen, in muddy water near shore of pond.
268. Philhydrus ochraceus Mels. I: one specimen, taken by stirring up water near shore.
269. Philhydrus perplexus Lec. I; XVI: several specimens, in pond.
270. Helocombus bifidus Lec. II: two specimens, in sphagnum moss near shore of lake. VIII: one specimen, in wet debris.
271. Hydrocombus fimbriatus Melsh. XV: one specimen, under board on shore.
272. Hydrocombus lacustris Lec. II: one specimen, in mud on shore of lake.
273. Hydrobius tessellatus Ziegl. II: one specimen, in wet sphagnum moss.
274. Hydrobius fuscipes L. II: one specimen, in water filling hoof-print of deer.
275. Hydrobius infuscatus Mots. II: one specimen, in debris by edge of lake.
276. Creniphilus subcupreus Say. XV: one specimen, under wet debris on shore.
277. Sphaeridium scarabaeoides L. II; two specimens, in damp debris on shore of lake. VIII: one specimen, in wet debris.

278. Cercyon centromaculatum Sturm. VIII: one specimen, under dead bird on shore-line.
279. Cercyon praetextatum Say. VIII: one specimen, under dead fish near water edge.
280. Cercyon anale Payk. XIV: three specimens, under debris near shore of pond. XV: three specimens, in debris on shore.
281. Phoenonotum extriatum Say. II: one specimen, in muddy debris.
282. Cryptopleurum minutum Fab. XVI: three specimens, running in mud on shore of pond.

SILPHIDAE

283. Necrophorus orbicollis Say. VIII: one specimen, on dead fish. XI: one specimen, under dead mouse. XVII: three specimens, on or about dead bird.
284. Necrophorus marginatus Fab. IX: one specimen, under dead gull.
285. Necrophorus vespilloides Herbst. IX: three specimens, under dead gull. XII: one specimen, under dead gull in jack pine grove near post-office.
286. Necrophorus tomentosus Web. VIII: one dead specimen, under debris. XVII: one specimen, under dead bird.
287. Silpha surinamensis Fab. IX: one specimen, on dead gull; several observed. XI: one, under dead mouse by side of road. XII: two specimens; about fifty observed about body of skunk near post-office.
288. Silpha lapponica Herbst. XVII: two specimens, under dead bird; others observed.
289. Silpha inaequalis Fab. VIII: one specimen, in putrid remains of bird.
290. Silpha noveboracensis Forst. XII: one specimen, under dead gull in jack pine grove near post-office.
291. Silpha americana L. Va: one specimen, in decayed fungus.
292. Choleva basillaris Say. II: one specimen, in old field-mouse nest near shore.

293. Choleva clavicornis Lec. XIII: one specimen, from rubbish in barnyard.
294. Anistoma valida Horn. XII: two specimens, in decayed fungus in jack pine grove near post-office.
295. Liodes globosa Lec. XII: several specimens, about dead body of gull in jack pine grove near post-office.

STAPHYLINIDAE

296. Homalota plana Gyll. VI: one specimen, from fungus growing on log.
297. Homalota trimaculata Er. VI: two specimens, under sphagnum moss.
298. Atheta aemula Er. VI: one specimen, in fungus.
299. Atheta flaveola Melsh. VI: one specimen, in fleshy fungus.
300. Atheta punctata Blatchley. VI: one specimen, in fungus.
301. Atheta sordida Marsh. VI: one specimen, found by sifting leaves at base of tree.
302. Aleochara lata Grav. IV: one specimen, under chip. X: one specimen, under board. XIII: one specimen, under board.
303. Aleochara bimaculata Grav. Va: two specimens, in old fungus growing at base of cedar.
304. Heterothops fusculus Lec. VI: one specimen, under leaves at base of tree.
305. Quedius fulgidus Fab. IV: one specimen, in nest of mouse in hollow log at top of ridge. XV: one specimen, in old mouse nest near shore.
306. Quedius peregrinus Grav. VI: one specimen, under moss. XIII: one specimen, under straw.
307. Quedius capucinus Grav. VI: one specimen, in fungus in low part of forest.
308. Quedius desertus Horn. VI: one, in fungus. XIII: one specimen, under straw.
309. Quedius laevigatus Gyll. II: one specimen, under debris on shore of lake. VI: two specimens, in sphagnum moss.

310. QUEDIUS HYPERBOREUS Er. VI: one specimen, under sphagnum moss. VIII: two specimens, under damp debris.
311. QUEDIUS FEROX Lec. II: one specimen, under beaver chip on shore.
312. QUEDIUS VERNIX Lec. II: one specimen, under debris on shore of lake.
313. CREOPHILUS VILLOSUS Grav. XI: one specimen, under dead bird by side of road.
314. STAPHYLINUS VULPINUS Nordm. II: one specimen, under debris.
315. STAPHYLINUS MACULOSUS Grav. II: one specimen, on deer dung on shore of lake. XI: one specimen, on horse dung in forest road.
316. STAPHYLINUS FOSSATOR Grav. Va: one specimen, on decayed fungus. IXa: one specimen, under bark on ground.
317. STAPHYLINUS VIOLACEUS Grav. VI: one specimen, under bark of partly decayed log.
318. PHILONTHUS POLITUS Fab. XII: several specimens, in horse dung on road near post-office. XIII: three specimens, under dung.
319. PHILONTHUS FURVUS Nord. XI: one specimen, under moss by side of road.
320. PHILONTHUS UMBRINUS Grav. II: one specimen, under debris.
321. PHILONTHUS DEBILIS Grav. XI: one specimen, under moss by side of forest road. XVIII: one specimen, under board.
322. PHILONTHUS FUSIFORMIS Melsh. II: one specimen, under debris with *P. umbrinus*. XII: one specimen, under board near post-office. XIV: one specimen, under damp debris by edge of pond.
323. PHILONTHUS BRUNNEUS Grav. VI: two specimens, found by sifting sphagnum moss.
324. PHILONTHUS CYANIPENNIS Fab. VI: one specimen, in fleshy fungus. XVIII: one specimen, in fungus.
325. PHILONTHUS BLANDUS Grav. VI: one specimen, in fungus. XIX: one, in fungus, near shore of Whitefish Bay.
326. PHILONTHUS APICALIS Say. VI: one specimen, under log.

327. Xantholinus cephalus Say. IV: three specimens, under bark of spruce stumps on ridge. VI: two specimens, under bark of spruce stump.
328. Xantholinus obsidianus Melsh. VI: one specimen, under sphagnum moss.
329. Xantholinus obscurus Er. IV: one specimen, under bark of birch stump. XVII: one specimen, under debris near shore of bay.
330. Stenus flavicornis Er. IV: two specimens, under bark of spruce stumps. XII: four specimens, under bark of spruce stump near post-office. XIX: two specimens, under bark of log on ridge near trail.
331. Lathrobium grande Lec. II: two, found under chips. VI: two specimens, under moss. Va: one, under leaves at side of log, cedar swamp.
332. Lathrobium punctulatum Lec. IV: one specimen, under bark of spruce stump.
333. Lathrobium collare Er. VI: one specimen, found by sifting leaves.
334. Lathrobium obtuseum Casey. IV: two specimens, under bark of spruce stumps.
335. Lathrobium simplex Lec. II: nine specimens, under damp debris.
336. Stilicus angularis Lec. VI: one specimen, found by sifting leaves.
337. Stilicus dentatus Say. VI: one specimen, found by sifting leaves.
338. Stilicus biarmatus Lec. IV: two specimens, under bark of spruce stumps.
339. Lithocharis confluens Say. IV: two specimens, under bark of spruce stumps.
340. Paederus littorarius Grav. II: one, under chip. XV: two specimens, under board.
341. Sunius prolixus Er. IV: two specimens, under bark of stumps.
342. Sunius discopunctus Say. IV: three specimens, under bark of spruce stumps.

343. SUNIUS BREVIPENNIS Aust. II: one specimen, under debris.
344. TACHINUS MEMNONIUS Grav. Va: one specimen, in fungus at base of stump. XVII: two specimens, in partly decayed fungus near shore of bay.
345. TACHINUS SCUTATOR Horn. IV: one specimen, under bark of spruce stump. VI: three specimens, under bark of log. XVIII: three specimens, in decaying fungus. XIX: one specimen, in decaying fungus near trail.
346. TACHINUS FLAVIPENNIS Dej. VI: one specimen, in fleshy fungus.
347. TACHINUS LURIDUS Er. Va: two specimens, in fungus at base of stump.
348. TACHINUS FIMBRIATUS Grav. Va: four, in fungi, cedar swamp. XVII: two specimens, in decayed fungus near shore.
349. TACHINUS PICIPES Er. VI: one specimen, in fungus.
350. TACHINUS PALLIPES Grav. Va: two specimens, in fungus at side of cedar log. VI: two specimens, in fungus.
351. TACHINUS CIRCUMCINCTUS Makl. Va: three specimens, in fungus at side of cedar log. VI: two specimens, in fungus.
352. TACHINUS NITIDULOIDES Horn. Va: one specimen, in fleshy fungus.
353. TACHYPORUS MACULIPENNIS Lec. IV: one specimen, under bark of birch stump. VI: one specimen, under bark of log.
354. TACHYPORUS JOCOSUS Say. IV: one specimen, under bark of spruce stump.
355. TACHYPORUS CHRYSOMELINUS L. IV: four specimens, under bark of spruce stump. XVII: one specimen, in decayed fungus near shore.
356. TACHYPORUS BRUNNEUS Fab. IV: one specimen, under leaves at base of birch stump.
357. CONOSOMA LITTOREUM L. IV: three specimens, under damp leaves at base of stumps. XII: two specimens, under loose bark of spruce stump near post-office.
358. CONOSOMA KNOXII Lec. IV: two specimens, under decayed leaves at base of stump. XII: one specimen, under loose bark of spruce stump near post-office.

359. Boletobius intrusus Horn. Va: two specimens, in fungi in cedar swamp. VI: one specimen, in fungus.
360. Boletobius cincticollis Say. IV: three specimens, under bark of old spruce stumps. VI: six specimens, under sphagnum moss. XII: two specimens, under bark of spruce logs near post-office.
361. Boletobius anticus Horn. VI: one specimen, under dead leaves. XIII: two specimens, under dung. XI: one, under manure on road. XVIII: one specimen, under damp leaves.
362. Boletobius pygmaeus Fab. VI: one specimen, in fungus.
363. Mycetoporus americanus Er. VI: one specimen, found by sifting leaf debris.
364. Oxyporus femoralis Grav. VI: two specimens, in fleshy fungus. XIX: one specimen, in fungus by trail to bay.
365. Oxyporus rufipennis Lec. VI: two specimens, from fungus.
366. Oxyporus 5-maculatus Lec. VI: one specimen, in fungus.
367. Bledius tau Lec. IV: several specimens, under bark of spruce stump.
368. Bledius borealis Blatchley. II: one specimen, beneath debris.
369. Oxytelus sculptus Grav. VI: two specimens, found by sifting sphagnum moss.
370. Oxytelus pennsylvanicus Er. VI: one specimen, found by sifting leaves.
371. Trigonodemus striatus Lec. VI: one specimen, found by sifting damp leaves at base of tree.
372. Olophrum obtectum Er. VI: one specimen, under leaves at base of tree.
373. Pycnoglypta lurida Gyll. Va: two specimens, in fungus at base of stump.
374. Megarthrus americanus Sachse. VI: one specimen, from fungus.
375. Megarthrus excisus Lec. Va: one specimen, in fungus by side of log.

SCAPHIDIIDAE

376. Boeocera concolor Fab. XIX: two specimens, in decayed fungus near trail.

PHALACRIDAE

377. Eustilbus apicalis Melsh. XIX: two specimens, found by sweeping herbage by side of trail.

COCCINELLIDAE

378. Anisosticta strigata Thunb. VIII: one specimen, on log near water's edge. XII: several specimens, found by beating willows by shore of pond near post-office.
379. Hippodamia 5-signata Kirby. III: three specimens, on spirea blossoms. VII: two specimens, found by beating foliage of wild cherry. IX: several specimens, found by beating willows. XII: several specimens, found by beating willows by shore of post-office pond.
380. Hippodamia convergens Guer. III: one specimen, found by beating willows. VII: three specimens, on foliage of maple. XI: one specimen, taken by beating foliage. XII: one specimen, on willow near beach of post-office pond.
381. Hippodamia 13-punctata L. III: three specimens, on spirea blossoms. VII: four specimens, found by beating foliage of wild cherry; others observed. VIII: two specimens, on willow branches thrown up in wash-up. IX: two specimens, on willows. XII: two, on willows.
382. Hippodamia parenthesis Say. III: two specimens, on willows by shore of lake. VII: specimens, on Juneberry bushes; others observed. VIII: two specimens, in wash-up; quite a number of dead ones observed on another date. IX: two specimens, on willows. XII: four specimens, on willows near lake shore near post-office; others observed. XIV: two, secured by beating willows.
383. Coccinella trifasciata L. XIV: two specimens, on herbage by shore of pond.

384. COCCINELLA 9-NOTATA Herbst. VII: one specimen, on oak.

385. COCCINELLA SANGUINEA L. III: two specimens, on spirea blossoms. XII: several specimens, secured by beating blossoms of mountain-ash near post-office.

386. ADALIA FRIGIDA Schn. VIII: several specimens, in wash-up.

387. HARMONIA PICTA Rand. II: several, on blossoms of flowering shrubs. VII: two specimens, crawling on trunk of oak.

388. ANISOCALVIA 12-MACULATA Gebl. VII: three specimens, on shad-bush.

389. ANISOCALVIA 14-GUTTATA var., approaching *A. victoriana* Casey. XII: several specimens, secured by beating shrubs near post-office.

390. ANATIS 15-PUNCTATA var. MALI Say. III: one specimen, on spirea. VIII: one specimen, in wash-up. XI: two, on foliage of maples. XII: two specimens, secured by beating blossoms of mountain-ash near post-office.

391. MYSIA PULLATA Say. VII: two specimens, on maple.

392. PSYLLOBORA 20-MACULATA Say. IX: two specimens, on willows.

393. CHILOCORUS BIVULNERUS Muls. XI: several specimens, secured by beating maple foliage.

394. BRACHYACANTHA URSINA Fab. XI: one specimen, flying along road.

395. HYPERASPIS BIGEMINATA Rand. III: one specimen, on spirea. IX: three specimens, secured by beating willows.

396. HYPERASPIS SIGNATA Oliv. VII: two specimens, on foliage of wild cherry.

ENDOMYCHIDAE

397. APHORISTA VITTATA Fab. VI: two specimens, found in fungus.

398. PHYMAPHORA PULCHELLA Newm. XII: one specimen, under bark of decayed yellow birch.

399. Endomychus biguttatus Say. Va: one specimen, in fungus by side of log. VI: one specimen, in fungus.

EROTYLIDAE

400. Mycotretus pulchra Say. IV: one specimen, in fungus growing at base of birch stump.
401. Tritoma thoracica Say. Va: six specimens, in fungus.

CUCUJIDAE

402. Silvanus bidentatus Fab. XII: one specimen, under bark of spruce stump near post-office.
403. Laemophlaeus biguttatus Say. XII: one specimen, under bark of pine log near post-office.
404. Brontes dubius Fab. IV: one specimen, under bark of spruce stump.

CRYPTOPHAGIDAE

405. Atomaria ephippiata Zimm. XII: one specimen, in fungus near post-office.
406. Cryptophilus integer Heer. Va: one specimen, in fungus growing on log.

MYCETOPHAGIDAE

407. Mycetophagus flexuosus Say. Va: one specimen, in fungus, at base of cedar stump. VI: three specimens, in fungus growing at base of stump.
408. Mycetophagus pluripunctatus Lec. V: one specimen, in partly burnt fungus on edge of fire area. XII: one specimen, in fungus near post-office.
409. Litargus sexpunctatus Say. XII: one specimen, secured by beating willow near post-office.

DERMESTIDAE

410. Dermestes lardarius L. XII: four specimens, under loose bark of yellow birch: two specimens, under dead gull in jack pine grove near post-office.

411. Anthrenus musaeorum L. XII: several specimens, on blossoms of mountain-ash near post-office.

HISTERIDAE

412. Hister merdarius Hoffm. VI: three specimens, in fungus.
413. Hister immunis Er. VIII: one specimen, under dead fish.
414. Hister lecontei Mars. IV: two specimens, under bark of spruce stump. XII: two specimens, under bark of spruce stump near post-office.
415. Hister basalis Lec. IV: one specimen, under bark of spruce stump.
416. Hister interruptus Beauv. XII: several specimens, in decayed fungus in jack pine grove near post-office.
417. Hister depurator Say. XII: eight specimens, in putrid fungus in jack pine grove near post-office.
418. Saprinus assimilis Payk. VI: one specimen, in decayed fungus. VIII: two specimens, under debris.
419. Saprinus sphaeroides Lec. VIII: one specimen, under debris on damp sand; another found burrowing into damp sand.
420. Saprinus fraternus Say. Va: one specimen, on partly decayed fungus. VI: two specimens, in decayed fungus. VIII: one specimen, under debris on shore.
421. Saprinus mancus Say. VIII: one specimen, under debris on damp sand.

NITIDULIDAE

422. Carpophilus brachypterus Say. XII: one specimen, at sap of birch near post-office.
423. Carpophilus decipiens Horn. XII: several specimens, at sap of maple near post-office.
424. Conotelus obscurus Er. XII: four specimens, on blossoms of mountain-ash near post-office.
425. Epuraea helvola Er. Va: one specimen, in fungus at base of cedar stump.
426. Epuraea corticina Er. IV: one specimen, under bark of birch.

427. Epuraea truncatella Mann. Va: two specimens, from decayed fungus.
428. Nitidula bipustulata L. VIII: one specimen, under dead gull.
429. Nitidula rufipes L. IX: several specimens, on bones of dead bird. XI: two specimens, on bones of dead crow. XII: two specimens, on bones of bird in jack pine grove. XVIII: two specimens, in fungus.
430. Nitidula ziczac Say. VIII: several specimens, among bones of dead gull. XII: two specimens, on bones of bird in jack pine grove near post-office.
431. Phenolia grossa Fab. Va: several specimens, in decayed fungus; others observed.
432. Omosita colon L. Va: two specimens, in decaying fungus at base of stump. XVIII: one specimen, in decayed fungus.
433. Soronia undulata Say. VI: several specimens, at sap running from maple.
434. Ips fasciatus Oliv. IV: four specimens, under chips placed on top of stumps. XVIII: several specimens, at sap of maple.
435. Ips sanguinolentus Oliv. VI: three specimens, at sap running from maple.
436. Rhizophagus brunneus Horn. XIX: eight specimens, under bark of spruce stump.

LATRIDIIDAE

437. Coninomus fulvipennis Mann. VIII: several specimens, under debris.
438. Melanophthalma distinguenda Com. XII: several specimens, on blossoms of a species of viburnum near post-office.

TROGOSITIDAE

439. Peltis ferruginea L. XVIII: two specimens, under bark of oak. XII: two specimens, under bark of spruce stump near post-office.

440. Tenebrioides castanea Melsh. IV: three, under bark on stumps.
441. Tenebrioides americana Kirby. XII: one specimen, under bark of pine log near post-office.

BYRRHIDAE

442. Cytilus sericeus Forst. VIII: several specimens, under damp debris; two specimens, under boards on damp sand.
443. Cytilus trivittatus Melsh. II: one specimen, under debris. VIII: two specimens, in debris; two specimens, under boards.
444. Byrrhus americanus Lec. VIII: four specimens, under boards and debris; two specimens, under debris. XI: one, under sphagnum moss. XVIII: several specimens, in moss at base of tree.
445. Byrrhus murinus Fab. VIII: several specimens, under boards.
446. Syncalypta echinata Lec. II: two specimens, at base of sedges; exceedingly rare in any locality.

HETEROCERIDAE

447. Heterocerus undatus Melsh. II: four specimens, on mud shore.

DASCYLLIDAE

448. Cyphon variabilis Thunb. III: five specimens, secured by beating shrubs. VIII: two specimens, under boards. XI: three specimens, secured by beating foliage of tamarack. XIV: one specimen, on willow near pond.

ELATERIDAE

449. Tharops ruficornis Say. XIX: one specimen, on maple branch.
450. Fornax orchesides Newm. VIII: one specimen, in wash-up.
451. Microrrhagus pectinatus Lec. XII: one specimen, on foliage of maple.

452. ADELOCERA IMPRESSICOLLIS Say. VI: two specimens, under bark of yellow birch.
453. ALAUS OCULATUS L. VI: one specimen, under bark of dead yellow birch.
454. ALAUS MYOPS Fab. VIII: three specimens, from wash-up, two alive, one dead.
455. CARDIOPHORUS CONVEXUS Say. VII: two specimens, secured by beating foliage of birch.
456. CARDIOPHORUS GAGATES Er. VI: one specimen, secured by beating foliage of yellow birch.
457. CARDIOPHORUS TENEBROSUS Lec. VII: two specimens, secured by beating wild cherry.
458. CARDIOPHORUS CONVEXULUS Lec. XIX: one specimen, secured by beating foliage of red-oak by trail to Whitefish Bay.
459. CRYPTOHYPNUS ABBREVIATUS Say. VI: one specimen, secured by beating foliage of yellow birch. VIII: two specimens, under board. XII: one specimen, secured by beating foliage of maple near post-office.
460. CRYPTOHYPNUS BICOLOR Esch. VII: one specimen, secured by beating branches of wild cherry. XII: one specimen, from foliage of birch near post-office.
461. MONOCEPIDIUS AURITUS Herbst. XII: two specimens, on viburnum blossoms, one type A, the other type B.
462. ELATER MANIPULARIS Cand. IX: one specimen, on spruce log. XII: one specimen, on blossoms on mountain-ash near post-office.
463. ELATER PEDALIS Germ. XII: one specimen, on blossoms of viburnum near post-office.
464. ELATER MIXTUS Hbst. VII: one specimen, secured by beating foliage of wild cherry. XVII: one specimen, on willow near shore of bay.
465. ELATER PULLUS Germ. XI: one specimen, on foliage of maple.
466. ELATER LINTEUS Say. XII: one specimen, under loose bark of red-oak near post-office.
467. ELATER RUBRICUS Say. XII: two specimens, on trunk of red-oak near schoolhouse.

468. Elater apicatus Say. VIII: part of a specimen, in wash-up. XI: one specimen, secured by beating foliage of maple.
469. Elater areolatus Say. XII: two specimens, secured by beating shrubs near post-office.
470. Drasterius elegans Fab. X: several specimens, under leaves at side of log.
471. Megapenthes rogersii Horn. XI: two specimens, secured by beating shrubbery by side of road.
472. Ludius abruptus Say. VIII: one specimen, on top of log. X: one specimen, secured by beating foliage of shad-bush.
473. Ludius hepaticus Germ. XI: one specimen, secured by beating foliage of maple. XIX: one specimen, on willow.
474. Ludius tarsalis Lec. VIII: two specimens, in wash-up.
475. Agriotes mancus Say. VII: one specimen, secured by beating foliage of jack pine. XII: two specimens, in birch near post-office.
476. Agriotes stabilis Lec. XI: two specimens, on foliage of white pine. XII: four specimens, on foliage of jack pine near post-office.
477. Agriotes fucosus Lec. VII: four specimens, secured by beating foliage of jack pine. XII: one specimen, on willow near post-office.
478. Agriotes pubescens Melsh. XII: four specimens, secured by beating foliage of red-oak near post-office.
479. Agriotes limosus Lec. VIII: one specimen, in wash-up. IX: one specimen, beating willow. XI: three specimens, secured by beating foliage of birch.
480. Agriotes oblongicollis Melsh. XV: one specimen, secured by sweeping herbage.
481. Dolopius lateralis Esch. XV: three specimens, taken by beating tamarack.
482. Melanotus decumanus Er. VIII: three specimens, in wash-up, two alive. IX: two specimens, on willows.
483. Melanotus castanipes Payk. XII: one specimen, on willows near post-office. XIX: several specimens, on willows in low places near trail.

484. MELANOTUS GLANDICOLOR Melsh. IV: two specimens, on spruce stump. IXa: two, on spruce log piles. XII: three specimens, under chips on top of spruce stump near post-office.

485. MELANOTUS COMMUNIS Gyll. XII: two specimens, in leaves in crotch of oak near post-office.

486. MELANOTUS FISSILIS Say. VIII: one specimen, in wash-up.

487. LIMONIUS AURIFER Lec. XV: two specimens, taken by beating willows.

488. LIMONIUS CONFUSUS Lec. VII: one specimen, on foliage of jack pine.

489. LIMONIUS AEGER Lec. XIV: four specimens, taken by beating willow near pond.

490. LIMONIUS BASILLARIS Say. VII: one specimen taken by beating foliage of cherry.

491. CAMPYLUS PRODUCTUS Rand. VIII: one specimen, in wash-up.

492. ATHOUS BRIGHTWELLI Kirby. XIX: one specimen, taken by beating willows in low places near trail.

493. ATHOUS CUCULLATUS Say. XI: one specimen, taken by beating foliage of balsam.

494. ATHOUS REFLEXUS Lec. VI: one specimen, taken by beating foliage of birch.

495. ATHOUS SCAPULARIS Say. XII: two specimens, from foliage of red-oak near post-office.

496. ATHOUS DISCALCEATUM Say. IXa: one specimen, crawling on spruce log pile.

497. NOTHODES DUBITANS Lec. XV: one specimen, taken by sweeping herbage.

498. SERICOSOMUS HONESTUS Rand. VIII: one specimen, in wash-up.

499. SERICOSOMUS VIRIDANUS Say. XII: one specimen, on willows near post-office.

500. SERICOSOMUS INCONGRUUS Lec. VIII: one specimen, in wash-up.

501. CORYMBITES VIRENS Sch. VIII: one specimen, crawling on log.

502. Corymbites tesselatus L. VI: one specimen, taken by beating branches of yellow birch. VIII: one specimen, in wash-up, crawling on board.
503. Corymbites resplendens Esch. VI: two specimens, taken by beating branches of birch. VIII: three specimens, in wash-up; others observed.
504. Corymbites cylindriformis Herbst. VIII: one specimen, on board.
505. Corymbites spinosus Lec. XIX: two specimens, taken by beating foliage of oak near trail.
506. Corymbites insidiosus Lec. XI: one specimen, taken by beating foliage of maple. XVII: one specimen, in wash-up.
507. Corymbites sulcicollis Say. XVII: one specimen, on sandy shore of bay.
508. Corymbites triundulatus Rand. VI: eight specimens, taken by beating branches of spruce.
509. Corymbites propola Lec. XI: two specimens, flying over road; four secured by beating branches of white pine.
510. Corymbites hieroglyphicus Say. VI: two specimens, on foliage of pine by edge of small clearing in forest. VIII: three, found in wash-up. XI: three specimens, flying about foliage of white pine.
511. Corymbites cruciatus L. III: one specimen, on shrubs. IX: one specimen, crawling on board. X: one, under bark of yellow birch.
512. Corymbites aeripennis Kirby. VI: one specimen, under bark of yellow birch. VIII: four specimens, from wash-up; fairly common all along beach. XI: four specimens, on foliage of white pine and spruce.
513. Corymbites inflatus Say. XV: two specimens, taken by sweeping low herbage near edge of pond.

BUPRESTIDAE

514. Chalcophora virginiensis var. lacustris Lec. IV: five specimens, on branch of pine, pine tops. XII: several specimens, resting on sides of spruce stumps near post-office.

515. Chalcophora liberta Germ. VI: two specimens, on spruce stump.
516. Dicerca prolongata Lec. VI: one specimen, crawling on spruce log pile in woods.
517. Dicerca divaricata Say. IXa: one specimen, on spruce log pile. XVII: two specimens, on log pile.
518. Dicerca obscura var. lurida Fab. XII: two specimens, on small overturned white pine. XVII: one specimen, crawling on spruce log pile near shore.
519. Dicerca spreta Gory. IXa: one specimen, on spruce log pile; one other observed.
520. Dicerca tenebrosa Kirby. IXa: one specimen, on spruce log pile.
521. Dicerca tuberculata Chev. IXa: several specimens, resting on spruce logs near bank.
522. Poecilonata cyanipes Say. IXa: three specimens, crawling on spruce logs; others observed. X: one, crawling on spruce stump. XII: several specimens, on small overturned white pine near post-office.
523. Buprestis lineata Fab. VI: four specimens, crawling on spruce log pile in woods; a few others observed. VIII: four specimens, crawling under debris. IXa: two specimens, crawling on spruce logs. XII: one specimen, crawling on spruce logs near post-office.
524. Buprestis nuttallii var. consularis Gory. VI: two specimens, crawling on spruce logs in forest. VIII: two specimens, crawling up from water's edge. XVII: two specimens, alive in wash-up. IXa: two specimens, crawling on spruce log.
525. Buprestis maculiventris Say. VI: four specimens, on spruce log pile. VIII: four specimens, resting on stones drying out in the sunlight after being thrown up on the shore by waves; others observed slowly crawling up from the water. IXa: two specimens, crawling on spruce logs.
526. Buprestis fasciata Fab. VIII: six specimens, drying in sunlight on top of stones well up from action of waves; great numbers crawling in sand or dead, lying where the

waves had thrown them; very common. IX: four specimens, crawling on sand-dune; others seen. XI: one specimen, crawling on trunk of spruce.

527. Buprestis fasciata Fab. VIII: eight specimens, within ten feet of the water. Nearly all were torpid or dead, and seemed to have become exhausted or to have died after crawling up from the water line. Most of the specimens were lying on their backs; many observed. The following year they were common likewise. Many were observed resting on the sand with the elytra partly raised, apparently with the object of drying out the wings; many dead or torpid specimens were lying on their backs on the sand. IX: several specimens, resting on sand-dune. IXa: one specimen, crawling on woodpile.

528. Buprestis sulcicollis Lec. VIII: one specimen, crawling on gravel beach. IX: one, resting on stone.

529. Buprestis striata var. impedita Say. VI: one specimen, crawling on spruce log. VIII: one specimen, dead in wash-up; another, resting on spruce log near water line. XVII: one specimen, on spruce log pile near shore.

530. Melanophila longipes Say. V: four specimens, on burning stumps and on hot ashes; one, on a stump where the heat and steam had split open the bark, was observed to be eating the partly roasted larva of a buprestid. Thousands were flying about the burnt-over area, resting on the charred sides of burning trunks, on the hot ashes, and on the writer. VIII: four specimens, in wash-up; many others observed; one specimen, on spruce log near edge of water; thousands dead and alive observed in wash-up. XVII: one specimen, on log pile.

531. Melanophila fulvoguttata Harr. IV: one specimen, crawling on spruce stump. V: several specimens, on scorched trunks of spruce on edge of burning area. VIII: four specimens, from wash-up; fairly common, dead and alive. XVII: one, on trunk of spruce. XVIII: four specimens, on trunk of hemlock.

532. MELANOPHILA AENEOLA Melsh. VI: three specimens, on trunk of white pine. VIII: several specimens, crawling on logs washed up on shore.

533. CHRYSOBOTHRIS FEMORATA Fab. IXa: several specimens, crawling on woodpile.

534. CHRYSOBOTHRIS FLORICOLA Gory. IV: one specimen, on trunk of pine. VI: one specimen, on trunk of pine. IXa: one specimen, on spruce log. XI: one specimen, on spruce log. XVII: one specimen, on board in wash-up.

535. CHRYSOBOTHRIS DENTIPES Germ. VIII: one specimen, crawling on stone. IXa: three specimens, on spruce logs; others observed. XI: one specimen, on trunk of pine.

536. CHRYSOBOTHRIS BLANCHARDI Horn. IXa: two specimens, crawling on spruce logs.

537. CHRYSOBOTHRIS TRINERVIA Kirby. IXa: two specimens, on spruce log pile.

538. AGRILUS TORQUATUS Lec. XI: four specimens, secured by beating foliage of pine.

539. AGRILUS OTIOSUS var. DEFECTUS Lec. X: one specimen, on trunk of oak.

540. AGRILUS BILINEATUS Web. XVII: one specimen, on trunk of poplar; others observed.

541. AGRILUS ACUTIPENNIS Mann. XVII: one specimen, on oak near shore of Whitefish Bay.

542. AGRILUS ANXIUS Gory. V: three specimens, on trunk of yellow birch, edge of burnt area. X: several specimens, resting and flying about trunks of paper birch.

543. AGRILUS POLITUS Say. V: one specimen, on trunk of paper birch. XVIII: two specimens, on trunk of fallen paper birch.

544. BRACHYS OVATA Web. XII: one specimen, feeding on foliage of small red-oak.

545. BRACHYS AEROSA Melsh. XI: one specimen, feeding on leaf of small oak. XII: one specimen, on foliage of small red-oak near post-office.

LAMPYRIDAE

546. Celetes basilis Lec. XI: one specimen, on foliage of maple. XII: one specimen, on foliage of willow near post-office.

547. Eros thoracicus Rand. XV: one specimen, on willow.

548. Eros aurora Herbst. VIII: one specimen, in wash-up.

549. Eros humeralis Fab. III: one specimen, secured by beating shrubs by shore of lake. XII: two specimens, in foliage of willow near post-office.

550. Eros crenatus Germ. XIX: one specimen, on willow.

551. Plateros modestus Say. XIX: six specimens, on shrubbery.

552. Calochromus perfacetus Say. XV: two specimens, on willows.

553. Lucidota atra Fab. III: one specimen, secured by sweeping herbage.

554. Ellychnia corrusca L. III: two specimens, secured by beating herbage by shore of lake.

555. Photinus pyralis L. III: one specimen, on willow by shore of lake. VII: one specimen, secured by beating foliage of wild cherry. XIX: one, on willow.

556. Photuris pennsylvanica DeG. VIII: two specimens, in wash-up. XI: two specimens, taken by beating foliage of maple.

557. Podabrus tomentosus Say. VII: nine specimens, taken by beating foliage of jack pine.

558. Telephorus vilis Lec. XIV: one specimen, on low herbage.

559. Telephorus carolinus Fab. III: six specimens, on spirea by edge of lake. VII: two specimens, on foliage of jack pine. VIII: three specimens, in wash-up. IX: four specimens, taken by beating willows.

560. Telephorus fraxini Say. XII: several specimens, taken by beating willows near post-office.

561. Telephorus nigritulus Lec. IX: four specimens, on willows.

MALACHIDAE

562. Collops vittatus Say. VIII: one specimen; under debris on lake shore; two specimens, under debris in wash-up.

CLERIDAE

563. Trichodes nuttalli Kirby. III: two specimens, on spirea blossoms by shore of lake.
564. Enoclerus quadriguttatus Oliv. var. near dubius Spin. X: two specimens, on spruce stump.
565. Enoclerus muttkowskii Wolcott. IV: two specimens, sunning on spruce stumps. X: one specimen, on spruce stump; "rare in any locality."
566. Thanasimus dubius Fab. IV: three specimens, on spruce stump. VIII: two specimens, dead, on sand. XII: two specimens, sunning on spruce stump near post-office.
567. Thanasimus undulatus Say. XII: one specimen, on spruce stump near post-office.
568. Thanasimus undulatus var. nubilus Klug. IV: two specimens, sunning on spruce stumps.
569. Phyllobaenus dislocatus Say. VI: one specimen, on spruce log pile in small clearing in woods.
570. Chariessa pilosa Forst. VI: one specimen, taken by beating shrubs in small opening in woods.
571. Necrobia violaceus L. XIII: one specimen, on bones in barnyard.

PTINIDAE

572. Hadrobregmus errans Melsh. VIII: two specimens, in debris. XV: one, under debris. XVII: one specimen, in wash-up.
573. Hadrobregmus carinatus Say. VIII: two specimens, under board.
574. Anobium notatum Say. IV: one specimen, on dead paper birch.
575. Ptilinus ruficornis Web. IV: one specimen, on dead branch of oak.

576. Bostrychus bicornis Web. IV: one specimen, on dead paper birch.
577. Dinoderus substriatus Payk. IV: one specimen, under chip on top of spruce stump.

CIOIDAE

578. Cis fuscipes Mellie. XII: one specimen, under fungus on stump.

LUCANIDAE

579. Lucanus placidus Say. XII: two specimens, in dead wood at base of bass-wood near post-office.
580. Platycerus depressus Lec. VI: one specimen, dug out of dead wood in red-oak. XII: one specimen, under log near post-office.
581. Ceruchus piceus Web. VI: one, dug out of rotten red-oak. VIII: two specimens, under board. XII: two specimens, on dead wood of red-oak near post-office.

SCARABAEIDAE

582. Onthophagus hecate Panz. IV: two specimens, in decayed fungus at base of stump. VIII: one specimen, in wash-up. XVII: two specimens, in decayed fungus.
583. Aegialia spissipes Lec. VIII: one specimen under board on shore; a very rare species in any locality.
584. Aphodius hamatus Say. Va: one specimen, in decayed fungus. VIII: one specimen, in wash-up. XI: two specimens, in dung. XIII: four specimens, in dung; others observed. XIX: two specimens, in deer dung on trail.
585. Aphodius fimetarius L. XI: three specimens, in dung. XII: one specimen, in dung in road to post-office.
586. Aphodius ruricola Melsh. II: two specimens, under debris. Va: two specimens, in decayed fungus. VIII: several specimens, under boards and debris. XIII: two specimens, in dung. XVII: two specimens, in wash-up.
587. Aphodius foetidus Fab. XII: two specimens, in dung on road to post-office.

588. Aphodius granarius L. XVII: three specimens, in decayed fungus near shore.
589. Aphodius vittatus Say. XIX: two specimens, in deer dung on trail to bay.
590. Aphodius inquinatus Herbst. VIII: one specimen, in dung on lake shore.
591. Geotrupes egeriei Germ. XVIII: one specimen, in fungus.
592. Geotrupes blackburnii Fab. XIX: one specimen, in deer dung on trail to bay.
593. Geotrupes balyi Jck. XIX: one specimen, in deer dung on trail to bay.
594. Trox unistriatus Beauv. XII: one specimen, under dead gull in jack pine grove near post-office.
595. Trox foveicollis Harr. IX: two specimens, under dead gull. XIV: one, under dead gull.
596. Hoplia barbata Blatchley. III: two specimens, on blossoms of spirea. VIII: one specimen, in wash-up. IX: one, on willow. XII: one specimen, on spirea blossoms near post-office.
597. Hoplia trifasciata Say. III: one specimen, on iris blossoms on shore. XII: one, on viburnum blossoms.
598. Dichelonycha elongata Fab. IV: one specimen, taken by beating birch on ridge. XIX: one specimen, on willows.
599. Dichelonycha subvittata Lec. IX: two specimens, on small birch.
600. Dichelonycha fuscula Lec. XIX: two specimens, on willows near trail.
601. Dichelonycha albicollis Burm. VIII: one specimen, in wash-up. XI: one, secured by beating white pine. XII: two specimens, taken by beating foliage of small white pine near post-office.
602. Serica vespertina Gyll. VIII: one specimen, alive in wash-up; a second one, dead on the water's edge. XVII: one specimen, in wash-up.
603. Serica tristis Lec. VIII: two specimens, under boards near water's edge.

604. Serica fimbriata Lec. XI: one specimen, under moss.

605. Serica sericea Ill. XIX: one specimen, dead on trail.

606. Serica carinata Blatchley. VIII: one specimen, under debris.

607. Macrodactylus subspinosus Fab. X: two specimens, on wild rose blossoms; others observed.

608. Diplotaxis sordida Say. XII: two specimens, under dead gull in jack pine grove near post-office.

609. Diplotaxis tristis Kirby. VIII: one specimen under board by shore of lake. XI: one specimen, taken by beating foliage.

610. Lachnosterna fusca Froh. XII: one dead specimen, on sand under sweet-gale bushes near post-office.

611. Lachnosterna dubia Smith. VIII: several specimens, dead in wash-up. IX: a small number of dead specimens, scattered about on sand under willows and other shrubs.

612. Lachnosterna marginalis Lec. IX: one specimen, crawling on willow.

613. Lachnosterna rugosa Melsh. VIII: two specimens, in wash-up. XII: one specimen, flying at night near post-office. XIX: three specimens, on willows near trail.

614. Lachnosterna grandis Smith. VIII: several specimens, in debris of wash-up.

615. Lachnosterna gibbosa Burm. IX: three specimens, in foliage of willows. XII: one specimen, on willows near shore.

616. Lachnosterna crenulata Froh. IX: one specimen, taken by beating willows.

617. Strigoderma arboricola Fab. IX: two specimens, flying about willows.

618. Cotalpa lanigera L. VIII: one specimen, old and battered, in wash-up.

619. Ligyrus relictus Say. VIII: one dead specimen, in wash-up.

620. Osmoderma scabra Beauv. VIII: two specimens, in wash-up. IX: one specimen, under board. IXa: one specimen, in spruce log pile. XVII: one specimen, on log pile near shore.

621. Trichius piger Fab. III: two specimens, in flowers of dewberry. VIII: one specimen, alive in wash-up. XII: one specimen, on blossoms of mountain-ash near post-office.
622. Trichius affinis Gory. XIX: one specimen, in blossoms of red raspberry near trail.

SPONDYLIDAE

623. Parandra brunnea Fab. VI: two specimens, in dry rotted oak.
624. Spondylis upiformis Mann. VIII: two specimens, under pine boards on lake shore.

CERAMBYCIDAE

625. Orthosoma brunneum Forst. XVIII: one specimen, on trunk of pine.
626. Tragosoma harrisii Lec. VI: one specimen, on pine log. VIII: two specimens, in wash-up, one dead, one alive. XI: one specimen, on pine stump.
627. Asemum moestum Hald. VIII: fifteen specimens, in wash-up, nearly all alive; common.
628. Criocephalus agrestis Kirby. VI: two specimens, on trunk of pine in forest. VIII: several specimens, in wash-up, one dead. IXa: several specimens, under-side of spruce logs in log pile.
629. Tetropium cinnamopterum Kirby. VI: one specimen, crawling on trunk of pine.
630. Gonocallus collaris Kirby. VIII: one specimen, crawling on log washed up on shore.
631. Physocnemum brevilineum Say. XI: one specimen, on trunk of yellow birch. XII: one, on blossoms of shrub.
632. Phymatodes dimidiatus Kirby. III: two specimens, on spirea blossoms. VI: one specimen, on trunk of spruce. VIII: one specimen, dead under debris. XII: one, on blossoms of shrub.
633. Merium proteus Kirby. III: one specimen, on spirea blossoms.

634. ELAPHIDION VILLOSUM Fab. XI: one specimen, on branch of maple. XII: one, secured by beating foliage of maple.

635. MOLORCHUS LONGICOLLIS Lec. III: one specimen, on flowers of spirea.

636. CALLIMOXYS SANGUINICOLLIS Oliv. XII: two specimens, on blossoms of spirea.

637. CALLOIDES NOBILIS Say. IXa: one specimen, on spruce log. XI: one specimen, on trunk of yellow birch.

638. ARHOPALUS FULMINANS Fab. IXa: one specimen, in woodpile.

639. XYLOTRECHUS COLONUS Fab. IV: three specimens, on decayed maple on top of ridge. VI: four specimens, on trunks of maple. XIX: four specimens, on spruce log.

640. XYLOTRECHUS SAGITTATUS Germ. VI: two specimens, on trunk of pine.

641. XYLOTRECHUS UNDULATUS Say. IV: one specimen, on spruce stump. VI: three specimens, on trunks of spruce. VIII: four specimens, from wash-up, two alive. IXa: three specimens, sunning on spruce logs.

642. NEOCLYTUS MURICATULUS Kirby. III: one specimen, on spirea. IV: one specimen, crawling on spruce stump. VIII: two specimens, in debris on shore; one specimen, in wash-up. XI: one specimen, on small white pine. XII: one, taken by beating branches of spruce.

643. NEOCLYTUS ERYTHROCEPHALUS Fab. III: one specimen, on spirea blossoms.

644. CLYTANTHUS RURICOLA Oliv. VIII: one specimen, dead in debris. XVII: one specimen, in blossoms of wild rose near shore.

645. DESMOCERUS PALLIATUS Forst. XIX: one specimen, on willow near trail.

646. ENCYCLOPS CAERULEUS Say. VI: one specimen, taken by beating foliage of yellow birch.

647. RHAGIUM LINEATUM Oliv. VI: three specimens, in crevices of pine stumps. IXa: one specimen, on spruce logs. XII: three, under chips placed on top of pine stumps.

648. PACHYTA MONTICOLA Rand. XII: two specimens, underside of spruce log.
649. PACHYTA RUGIPENNIS Newm. XVIII: one specimen, on trunk of fallen pine.
650. ANTHOPHILAX VIRIDIS Lec. VIII: two specimens, alive in debris on shore.
651. ACMAEOPS PROTEUS Kirby. IXa: one specimen, on spruce log. XII: three specimens; black var., on milfoil blossoms.
652. ACMAEOPS PRATENSIS Laich. III: two specimens, on spirea. VIII: one specimen, in debris.
653. GAUROTES CYANIPENNIS Say. III: two specimens, on blossoms of spirea. VI: one specimen, on trunk of yellow birch. VIII: one specimen; dead in wash-up.
654. BELLAMIRA SCALARIS Say. VI: one specimen, on trunk of yellow birch. VIII: one specimen, dead in wash-up. IXa: one specimen, crawling on birch log.
655. TYPOCERUS VELUTINUS Oliv. III: two specimens, on dewberry blossoms. VIII: two specimens, in wash-up.
656. LEPTURA PLEBEJA Rand. black form. III: one specimen, on spirea blossoms.
657. LEPTURA AMERICANA Hald. XVII: one specimen, on blossoms of mountain-ash.
658. LEPTURA NIGRELLA Say. III: four specimens, on spirea and dewberry blossoms. IV: one specimen, on fallen paper birch. VIII: two specimens, from wash-up; fairly common, about half-dead; four specimens, from wash-up, alive; others observed, alive and dead. IXa: two specimens, crawling on log pile.
659. LEPTURA NIGRELLA Say., light form. III: one specimen, on spirea blossoms. IV: several specimens, on trunk of birch. VIII: one specimen, in wash-up. IXa: one specimen, on spruce log. XI: two specimens, beaten from foliage of birch. XVII: one specimen, in wash-up.
660. LEPTURA CANADENSIS Fab. III: two specimens, male and female *in coitu*, on blossoms of spirea. VIII: four specimens, in wash-up; many others observed, alive and dead. IXa: two specimens, crawling on spruce log pile.

661. LEPTURA RUBRICA Say. III: two specimens, on spirea.

662. LEPTURA VAGANS Oliv. III: four specimens, on spirea blossoms.

663. LEPTURA CHRYSOCOMA Kirby. III: two specimens, on spirea; many observed. VIII: two specimens, in wash-up; many others observed, some alive, many dead and waterworn.

664. LEPTURA PROXIMA Say. III: two specimens, in dewberry blossoms. IXa: two specimens, on spruce log piles.

665. LEPTURA BIFORIS Newm. XII: one specimen, on blossoms of mountain-ash.

666. LEPTURA TIBIALIS Lec. III: one specimen, in dewberry blossoms. IV: one specimen, on under-side of fallen birch. VI: one specimen, taken by beating foliage of maple. VIII: one specimen, in wash-up XII: one, on blossoms of milfoil

667. LEPTURA TIBIALIS Lec. var. XII: two, found on blossoms of milfoil.

668. LEPTURA VITTATA Germ. III: two specimens, on dewberry blossoms. VIII: one specimen, in wash-up. IXa: one specimen, on log pile.

669. LEPTURA PUBERA Say. III: two specimens, on meadowsweet. XII: three, on blossoms of milfoil.

670. LEPTURA MUTABILIS Newm. IV: one specimen, running about on fallen birch.

671. MONOHAMMUS TITILLATOR Fab. VI: several specimens, on trunks of pine.

672. MONOHAMMUS SCUTELLATUS Say. IV: one specimen, under-side of spruce log; one or two seen on or under every log. V: one specimen, on charred trunk of spruce. VIII: four specimens, alive in wash-up; fairly common. IXa: one, taken on spruce log piles; others observed. XI: one specimen, on spruce.

673. MONOHAMMUS CONFUSOR Kirby. IV: one specimen, on under-side of spruce log; others seen. V: one specimen, flying from burning area. VIII: one specimen, in wash-up. VI: one specimen, on pine log.

674. LEPTOSTYLUS COMMIXTUS Hald. VI: one specimen, on pine trunk.
675. LEPTOSTYLUS MACULA Say. VI: one specimen, on trunk of maple. VIII: one specimen, in wash-up.
676. UROGRAPHIS FASCIATUS DeG. VI: one specimen, female, on trunk of maple. VIII: one specimen, in wash-up.
677. POGONOCHERUS MIXTUS Hald. VI: two specimens, taken by beating dead branch of pine. IXa: three specimens, resting on spruce logs.
678. SAPERDA CANDIDA Fab. XII: one specimen, at night, alighted on McAlpine's coat.
679. SAPERDA VESTITA Say. XVII: two specimens, in wash-up.
680. SAPERDA TRIDENTATA Oliv. XVII: two specimens, in wash-up.
681. SAPERDA MOESTA Lec. VIII: one specimen, in wash-up. IX: four specimens, on balm of Gilead; others observed.
682. SAPERDA CONCOLOR Lec. VI: one specimen, taken by beating willows.

CHRYSOMELIDAE

683. DONACIA HYPOLEUCA Lec. IX: five specimens, on sedges growing at edges of pool.
684. DONACIA PISCATRIX Lec. XVI: one specimen, in blossom of yellow water-lily.
685. DONACIA HIRTICOLLIS Kirby. Form with yellow brown elytra. I: eight specimens, on lily pads; numbers flying on surface of pond. XVI: four specimens, in partly opened buds of yellow water-lilies.
686. DONACIA PROXIMA Kirby. I: four specimens, on lily pads; not common. XVI: fifteen specimens, submerged about an inch and clinging to lily pads; hundreds observed.
687. DONACIA SUBTILIS Kunze. I: ten specimens, on sedges growing near shore. XVI: four specimens, on sedges growing in water of pond.
688. DONACIA RUGOSA Lec. I: two specimens, on sedges growing near shore. XVI: several specimens, on sedges.

689. Donacia emarginata Kirby. I: four specimens, on sedges. XVI: two specimens, on sedges.
690. Donacia megacornis Blatchley. I: three specimens, on sedges growing in water near shore. XVI: four specimens, on sedges growing in water of pond.
691. Orsodachna atra var. childreni Kirby. IX: two specimens, on willows. XV: one, taken by beating willows.
692. Syneta ferruginea Germ. XI: one specimen, taken by beating shrubs by side of road.
693. Lema trilineata Oliv. XII: two specimens, in potato blossoms near post-office.
694. Chlamys plicata Fab. III: two specimens, on goldenrod. XII: one specimen, taken by sweeping roadside herbage.
695. Bassareus formosus var. sulfuripennis Melsh. III: two specimens, taken by beating willows. XVII: one specimen, taken by beating willows near shore.
696. Cryptocephalus quadrimaculatus var. notatus Fab. IX: one specimen, on willow.
697. Cryptocephalus quadruplex Newm. XIV: two specimens on willows.
698. Cryptocephalus venustus var. hamatus Melsh. VIII: two specimens, on under-side of board. IX: two specimens, taken by beating small birch.
699. Pachybrachys autolycus var. difficilis Fall. XII: one specimen, on willow near post-office. III: one specimen, on willow.
700. Pachybrachys hepaticus Melsh. III: one specimen, on willow.
701. Pachybrachys infaustus Hald. III: one specimen, taken by beating willow. IX: two specimens, taken by beating willows.
702. Diachus auratus Fab. III: one specimen, taken by beating willows.
703. Adoxus vitis L. III: one specimen, on willow. IX: two, on willows. XIX: two, on willows.
704. Chrysochus auratus Fab. VIII: several specimens, on shore; occurred by hundreds in the distance of a mile, dead

and alive. X: one, on dogbane; only one, observed on proper food plant.

705. Graphops pubescens Melsh. III: two specimens, taken by sweeping herbage. XIV: one, found by beating shrubs.

706. Colapsis brunnea Fab. XII: one specimen, in strawberry blossoms near post-office. XIV: one, on strawberry vine.

707. Prasocuris vittata Oliv. I: one specimen, on water plants. XV: two, on marsh vegetation.

708. Leptinotarsa 10-lineata Say. XII: several specimens, on potato vines in patch near post-office; scarce.

709. Labidomera clivicollis Kirby. III: one specimen, on milkweed. IX: one, on milkweed.

710. Calligrapha elegans Oliv. III: two specimens, on goldenrod. IX: one specimen, on arrow-head in marshy place. XV: one, on marsh plants.

711. Calligrapha scalaris Lec. VIII: one specimen, dead in wash-up. XI: one specimen, on foliage of paper birch. XIX: one specimen, taken by beating small birch.

712. Calligrapha philadelphica L. III: one specimen, on willows. VIII: one specimen, in wash-up, dead and considerably water-worn.

713. Calligrapha multipunctata var. bigsbyana Kirby. III: one specimen, beating willows. XIV: two, on willows.

714. Gastroidea polygoni L. XIX: two specimens, on willows by edge of small marsh near trail.

715. Lina scripta Fab. III: one specimen, on willow. IX: on willows.

716. Lina obsoleta Say. III: three specimens, taken by beating willows. IX: two specimens, feeding on small willows. XIX: two specimens, on willow near trail.

717. Lina interrupta Fab. IX: two specimens, on willows.

718. Gonioctena arctica Mann. (?) VIII: one specimen, in wash-up.

719. Gonioctena pallida L. III: one specimen, on willows.

720. Cerotoma trifurcata Forst. IX: one specimen, occurring on beach-pea.

721. Luperus varicornis Lec. VIII: two specimens, under boards on lake shore. IX: one specimen, under drifted weeds.

722. Diabrotica 12-punctata Oliv. III: three specimens, on spirea blossoms. VIII: one specimen, under board. XII: one specimen, taken by beating willows near post-office. XVII: two specimens, on willows near shore.

723. Trirhabda tomentosa L. III: two specimens, on willows. VIII: one specimen, alive in wash-up. IX: one specimen, taken by beating willows.

724. Trirhabda flavolimbata Mann. III: one specimen, on goldenrod. XVII: one specimen, on goldenrod near shore.

725. Trirhabda brevicollis Lec. III: one specimen, taken by beating willows. IX: one specimen, on willows.

726. Adimonia 6-vittata Lec. IX: one specimen, on willow.

727. Adimonia cavicollis Lec. VIII: one specimen, alive in debris. X: one, on wild cherry.

728. Galerucella marginella Kirby. XII: one specimen, on willow near lake shore.

729. Galerucella sagittariae Gyll. III: two specimens, taken by beating herbage.

730. Oedionychis gibbitarsis Say. IX: one specimen, on milfoil.

731. Oedionychis vians Ill. X: one specimen, on tansy blossoms.

732. Oedionychis vians var. concinna Fab. III: two specimens, on willows.

733. Oedionychis quercata var. limbalis Melsh. III: one specimen, taken by beating herbage.

734. Disonycha pennsylvanica Ill. IX: one specimen, on willows.

735. Disonycha quinquevittata Say. III: one specimen, on willows. VIII: one specimen, dead in wash-up. IX: several specimens, on willows. XIX: one specimen, on willow near trail.

736. Haltica bimarginata Say. III: one specimen, on goldenrod. VIII: one specimen, under debris.

737. Haltica chalybea Ill. XVII: one specimen, on willows near shore.

738. Haltica ignita Ill. III: one specimen, on foliage of goldenrod.

739. Haltica punctipennis Lec. VIII: several specimens, in wash-up; common. X: wild cherry trees swarming with these beetles; leaves partly destroyed.

740. Haltica cuprascens Blatchley. III: one specimen, taken by beating willows. XII: one specimen, taken by beating foliage of paper birch near post-office.

741. Crepidodera helxinus L. VIII: one specimen, on water's edge. XI: one specimen, on willow by side of forest road.

742. Chalepus rubra Web. XI: one specimen, taken by beating foliage of oak.

743. Chalepus nervosa Panz. III: two specimens, on goldenrod leaves. XVII: one specimen, on foliage near shore.

744. Coptocycla signifera Herbst. III: one specimen, on species of Convolvulus.

745. Chelymorpha aygus Herbst. X: one specimen, on dogbane. XIX: two specimens, on dogbane near trail to bay.

BRUCHIDAE

746. Bruchus mimus Say. XII: one specimen, on blossom of field-daisy by side of road to post-office.

TENEBRIONIDAE

747. Nyctobatus pennsylvanica DeG. IV: two specimens, under bark of dead birch; others seen. Va: several specimens, under bark of old birch growing at edge of cedar swamp. XII: several specimens, under bark of dead oak near post-office.

748. Iphthimus opacus Lec. IV: Va: two specimens, in partly dried fungus growing on side of log. VIII: four specimens, in wash-up, two dead, two alive; very common. XVII: several specimens, in wash-up; not common on this shore.

749. Upis ceramboides L. VIII: four specimens, in wash-up; very common, dead and alive. XVII: six specimens, in fresh fungi growing on old dock.
750. Haplandrus concolor Lec. IV: six specimens, under bark of dead birch. VIII: two specimens, under boards.
751. Xylopinus saperdioides Oliv. XII: one specimen, under bark of oak near post-office.
752. Tenebrio obscurus Fab. IV: four specimens, under bark of dead birch. VIII: four specimens, in wash-up. XVII: one specimen, in wash-up.
753. Tenebrio molitor L. VIII: one specimen, dead in wash-up.
754. Tenebrio tenebrioides Beauv. VIII: one specimen, dead in wash-up.
755. Diaperis maculata Oliv. Va: XII: three specimens, in fleshy fungus near post-office.
756. Hoplocephala bicornis Oliv. IV: several specimens, in partly dried fungus growing on spruce stump; many larvae observed.
757. Platydema americanum Lap. VIII: two specimens, in wash-up.
758. Boletotherus bifurcus Fab. IV: four specimens, in dried bracket fungus growing at base of spruce stump. XIX: four specimens, in dried bracket fungus; many more observed.
759. Boletophagus depressus Rand. IV: several specimens, in partly dried fungus, growing at base of spruce stump.

CISTELIDAE

760. Allecula punctulata Melsh. VIII: one specimen, crawling on log.
761. Hymnorus niger Melsh. VI: one specimen, in fungus growing at base of yellow birch. VIII: one specimen, under debris.
762. Isomira quadristriata Coup. Va: four specimens, in fungus in cedar swamp. VIII: four specimens, in wash-up.
763. Androchirus erythropus Kirby. IV: one specimen, on spruce stump.

MELANDRYIDAE

764. Penthe obliquata Fab. Va: one specimen, from growing fungus.
765. Synchroa punctata Newm. VI: three specimens, under loose bark of yellow birch. VIII: one specimen, thrown up on sand by waves.
766. Melandrya striata Say. IV: one specimen, running on stump.
767. Emmesa connectens Newm. VIII: one specimen, crawling on board.
768. Scotochroa basalis Lec. XII: one specimen, dead on sand beneath sweet-gale bush near post-office.
769. Serropalpus barbatus Schall. II: four specimens, under debris. VIII: four specimens, in wash-up and in debris, three alive, one dead. IX: four specimens, under boards. XVII: two specimens, under board on shore-line.
770. Dircaea liturata Lec. XII: one specimen, flying near post-office.
771. Eustrophus confinis Lec. VI: one specimen, in fungus.
772. Hallomenus scapularis Lec. VIII: two specimens, under debris.
773. Hallomenus debilis Lec. III: three specimens, taken by beating spirea. XIX: one, on shrub.

PYTHIDAE

774. Crymodes discicollis Lec. VIII: two specimens, in wash-up; one specimen on log. XII: two specimens, under chip traps on top of freshly cut spruce stumps near post-office.
775. Pytho depressus L. XII: four specimens, on under-side of firewood near post-office.
776. Priognathus monilicornis Rand. III: one specimen, in crevice of pine trunk on shore of marsh.
777. Salpingus alternatus Lec. XII: two specimens, secured by beating pine branches.

OEDEMERIDAE

778. Ditylus caeruleus Rand. IV: one specimen, on bark of spruce stump.

CEPHALOIDAE

779. Cephaloon lepturides Newm. III: three specimens, on spirea blossoms. VIII: ten specimens, picked up from wash-up; many observed.
780. Cephaloon ungulare Lec. VIII: six specimens, alive in debris.

MORDELLIDAE

781. Anaspis rufa Say. X: five specimens, on blossoms of wild rose.
782. Mordella scutellaris Fab. X: two specimens, on blossoms of wild rose. XII: one specimen, on blossoms of dewberry near post-office.
783. Mordella marginata Melsh. III: four specimens, on blossoms of spirea. X: two specimens, on wild rose blossoms.
784. Mordellistena biplagiata Helm. X: one specimen, on blossoms of wild rose.
785. Mordellistena comata Lec. X: two specimens, on blossoms of wild rose.

ANTHICIDAE

786. Notoxus bifasciatus Lec. XII: one specimen, from blossoms of mountain-ash.
787. Notoxus anchora Hentz. VIII: one specimen, under damp leaves by side of log on shore. XV: two, taken by beating foliage.
788. Malporus cinctus Say. XVII: one specimen, under debris on shore.
789. Formicomus mundus Lec. XII: several specimens, on spirea blossoms near post-office.

790. Anthicus floralis L. VIII: one specimen, in debris on shore. XII: three specimens, on blossoms of mountain-ash near post-office.

791. Anthicus scabriceps Lec. XII: two specimens, beaten from mountain-ash.

792. Anthicus ephippium Laf. VIII: two specimens, under damp debris.

793. Anthicus coracinus Lec. XII: one specimen, found by sifting leaves at base of spruce stump.

794. Anthicus granularis Lec. VIII: one specimen, under debris.

795. Anthicus melancholicus Laf. XVIII: three specimens, under log.

796. Sapintus fulvipes Laf. XVII: one specimen, under board near shore of bay.

797. Amblyderus pallens var. A Lec. VIII: three specimens, running about in damp sand near edge of water.

PYROCHROIDAE

798. Dendroides canadensis Lat. VI: six specimens, taken by beating foliage of maple.

799. Dendroides concolor Newm. VI: five specimens, under bark of yellow birch.

MELOIDAE

800. Macrobasis unicolor Kirby. III: one specimen, on ironweed. XII: one specimen, on willow near post-office.

801. Epicauta trichrus Pall. XIV: one specimen, on willow.

BRENTHIDAE

802. Eupsalis minuta Dury. XII: one specimen, on end of recently cut spruce log near post-office.

RHYNCHITIDAE

803. Auletes subfasciatus Dietz. XII.

804. Eugnamptus collaris Fab. III: one specimen, color var.,

taken by sweeping herbage. XI: one specimen, on herbage growing at side of road.

ATTELABIDAE

805. ATTELABUS RHOIS Boh. III: one specimen, taken by beating alders.

OTIORHYNCHIDAE

806. HORMORUS UNDULATUS Uhler. VIII: one specimen, under-side of chip on shore.
807. NEOPTOCHUS ADSPERSUS Boh. III: one specimen, taken by sweeping herbage. VIII: one specimen, on chip near water's edge; range heretofore given as Florida and Georgia.
808. OTIORHYNCHUS OVATUS L. VIII: one specimen, alive in wash-up. IX: two specimens, under board on moist sand. XI: one specimen, taken by beating foliage by side of road.
809. GEODERCES MELANOTHRIX Kirby. VIII: one specimen, alive in debris on shore.
810. PANDELETEJUS HILARIS Herbst. III: several specimens, on alder and smartweed.

CURCULIONIDAE

811. SITONA HISPIDULA Fab. IX: one specimen, on stem of sedge.
812. SITONA TIBIALIS Herbst. XII: one specimen, on herbage.
813. SITONA FLAVESCENS Marsh. III: one specimen, on foliage of willow. VI: one specimen, taken by beating willows in small marshy place in woods.
814. ITHYCERUS NOVEBORACENSIS Forst. VIII: three specimens, alive in wash-up.
815. HYPERA PUNCTATA Fab. VIII: one specimen, in wash-up.
816. PHYTONOMUS NIGRIROSTRIS Fab. IX: one specimen, on sedge. XI: three specimens, under leaves and moss by side of road. XII: one specimen, in red clover near post-office.
817. LEPYRUS GEMINATUS Say. III: one specimen, taken by beating willows. IX: one specimen, on willow.

818. Listronotus squamiger Say. II: three specimens, at roots of arrow-head by edge of lake. IX: one specimen, under board by edge of drying pond.
819. Listronotus callosus Lec. II: two specimens, on underside of boards on mud shore of lake. VIII: one specimen, in wash-up.
820. Listronotus nebulosus Lec. VI: one specimen, taken by sifting leaves at base of tree.
821. Listronotus frontalis Lec. XI: two specimens, under leaves.
822. Listronotus latiusculus Boh. XI: one specimen, under leaves by side of road. VI: one specimen, taken by sifting leaves at base of tree.
823. Hyperodes humilis Gyll. II: one specimen, under weeds by shore of lake.
824. Hyperodes solutus Boh. (?) XV: one specimen, on stem of arrow-head.
825. Pissodes strobi Peck. IV: three specimens, dug out of pine stumps; larvae of others observed. XII: two specimens, on and under bark of pine stump near post-office.
826. Desmoris constrictus Say. XI: one specimen, secured by sweeping herbage.
827. Hylobius confusus Kirby. IV: one specimen, dug out of spruce stump. VIII: two specimens, in debris on shore. XII: one specimen, on spruce stump. XVII: one specimen, from wash-up.
828. Lixus rubellus Rand. IX: one specimen, under board.
829. Notaris puncticollis Lec. VIII: one specimen, clinging to under-side of board.
830. Dorytomus laticollis Lec. IV: one specimen, at base of aspen. IX: two specimens, at base of sedges.
831. Dorytomus brevicollis Lec. IX: one specimen, captured by beating willow.
832. Magdalis perforata Horn. XI: one specimen, captured by beating branches of white pine.
833. Magdalis olyra Herbst. XI: two specimens, captured by beating foliage of maples.

834. Magdalis hispoides Lec. III: two specimens, on spirea blossoms. XI: three specimens, on maple foliage.

835. Magdalis pallida Say. IX: one specimen, captured by beating willow.

836. Magdalis austera var. substriata Fall. XI: one specimen, taken by beating branches of maple.

837. Acalyptus carpini Herbst. IX: one specimen, on willow.

838. Anthonomus signatus Say. XI: one specimen, on dewberry.

839. Anthonomus rufipennis Lec. VIII: one specimen, in debris on shore.

840. Anthonomus rufipes Lec. II: one specimen, on roots of goldenrod on shore. XII: one specimen, on willow near post-office.

841. Anthonomus crataegi Walsh. XI: one specimen, on small hawthorn near road.

842. Anthonomus squamulatus Dietz. III: one specimen, on spirea blossoms.

843. Orchestes puberulus Boh. III: one specimen, taken by beating shrubs.

844. Orchestes salicis L. IX: one specimen, on willow.

845. Orchestes niger Horn. XV: one specimen, found on willow.

846. Elleschus ephippiatus Say. IX: three specimens, taken by beating willows.

847. Miarus hispidulus Lec. VIII: several specimens, in wash-up.

848. Conotrachelus nenuphar Herbst. X: one specimen, taken by beating foliage of wild cherry.

849. Conotrachelus posticatus Boh. X: two specimens, taken by beating foliage of Juneberry bushes.

850. Tyloderma aereum Say. III: one specimen, taken by beating shrubs.

851. Cryptorhynchus lapathi L. VIII: one specimen, in wash-up.

852. Mononychus vulpeculus Fab. XV: two specimens, in blossoms of iris.

853. Coeliodes acephalus Say. III: two specimens, on spirea.

854. Coeliodes vitiosus Dietz. III: one specimen, taken by beating herbage.

855. Ceutorhynchus rapae Gyll. III: one specimen, on mustard near shore of Weatherhog Lake.

856. Ceutorhynchus septentrionalis Gyll. II: one specimen, taken in sweep-net.

857. Rhinoncus pericarpius L. IV: two specimens, taken by beating foliage of birch.

858. Rhinoncus pyrrhopus Lec. III: five specimens, on arrow-head. XI: two specimens, on dock by side of road.

859. Baris subsimilis Casey. III: two specimens, taken by sweeping low herbage.

860. Palenomus asperulus Dietz. IX.

861. Auleutes griseus Blatchley. IX.

862. Auleutes subfasciatus Dietz. III: two specimens, on blue flag.

863. Madarus undulatus Say. III: two specimens, taken by sweeping low herbage.

CALANDRIDAE

864. Rhodobaenus tredecimpunctatus Ill. III: one specimen, on ironweed. XIX: two specimens, on ironweed growing near side of trail.

865. Sphenophorus aequalis Gyll. XV: one specimen, under debris.

866. Sphenophorus pertinax Oliv. II: one specimen, under log on shore. XI: one specimen, under moss.

867. Sphenophorus robustus Horn. II: one specimen, under damp weeds on shore.

868. Sphenophorus scoparius Horn. II: two specimens, under damp debris on shore.

869. Sphenophorus melanocephalus Fab. IX: one specimen, under board.

870. Sphenophorus placidus Say. II: two specimens, under damp debris on shore. IX: two, under debris.

871. Sphenophorus villosiventris Chitt. II: two specimens under debris.
872. Sphenophorus incongruus Chitt. II: one specimen, under damp debris on shore.
873. Sphenophorus zeae Walsh. VIII: one specimen, from wash-up. XI: one specimen, under damp moss. XVII: one specimen, under debris on shore of bay.
874. Rhyncholus brunneus Mann. IX: one specimen, found on log.

SCOLYTIDAE

875. Pityophthorus sparsus Lec. IV: one specimen, under bark of spruce stump.
876. Xyleborus celsus Er. IV: one specimen, on bark of spruce stump.
877. Dryocoetes septentrionis Mann. X: one specimen, under bark of dead wild cherry.
878. Ips calligraphus Germ. XII: one specimen, on trunk of white pine near post-office.
879. Ips pini Say. III: several specimens, under bark of decaying tamarack. XVIII: two specimens, on trunk of pine.
880. Ips interruptus Mann. XVIII: one specimen, on branch of pine.
881. Dendroctonus terebrans Oliv. XVIII: two specimens, on trunk of pine.
882. Dendroctonus punctatus Lec. IV: one specimen, on bark of spruce tree. VI: one specimen, in bark of spruce.
883. Dendroctonus valens Lec. IV: one specimen, boring in bark of dead tamarack. VIII: one specimen, in wash-up. XI: one specimen, boring in bark of black spruce.
884. Hylurgops pinifex Fitch. XII: two specimens, under bark of pine near post-office.

ANTHRIBIDAE

885. Allandrus bifasciatus Lec. XI: two specimens, secured by beating foliage by side of road.
886. Euparius marmoreus Oliv. VI: one specimen, in woody fungus on log.

AFFINITIES OF WHITEFISH POINT COLEOPTERA

The great mass of the Whitefish Point beetles range east from Lake Superior through northern Ontario, Quebec, eastern Canada, Newfoundland, and New England. A number of species range west through Manitoba and Alberta, and a few reach British Columbia, Siberia, and northern Europe. A few that were taken at Whitefish Point occur in the Hudson Bay region. A considerable number of species occur as far south as the central middle states and a few reach Texas and even the West Indies.

Considerable difference in species found at other Lake Superior localities farther west will be seen in future papers by the writer. The most westerly locality produces species that occur in the Detroit region and are not found at Whitefish Point.

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DETROIT, MICHIGAN

NOTES ON THE LIFE-HISTORY AND HABITS OF MALLOPHAGA

BERTRAM A. BARBER

Very little is known of the life-history and habits of the small parasitic forms commonly called bird lice, although there has been considerable systematic work on the group. The following observations on experiments begun in the laboratory of the University of Michigan and continued at Hillsdale College may, therefore, be of some interest. Only a few species were used in the experiments, chiefly *Nirmus vulgatus* Kellogg, from the English sparrow, and *Docophorus communis* Nitzsch, from the red-winged blackbird. A large robust species from the crow was used in some of the later studies. Nearly every species of bird harbors from one to several species of Mallophaga. It is reported that the common domestic fowl is host to twelve of them. Specimens from blackbirds and crows were secured by shooting; English sparrows were caught in traps. The birds were carried to the laboratory in separate packages and carefully searched for live specimens and eggs.

In the case of the English sparrow (*Passer domesticus*), the eggs were found only on the contour feathers of the back and underparts, but on the red-winged blackbird (*Agelaius phoeniceus* Linn.) and the rusty blackbird (*Euphagus carolinus* Mull.), they were often found to be most numerous on the short bristly feathers surrounding the ear. When occurring in this situation, they were all fastened to the shaft of the feather, while those on contour feathers were attached to the barbules. In all cases they occurred near the base of the feather and on the side next to the body. It seems natural that they should be deposited there, since careful search of freshly killed birds and observation on the feeding habits of the Mallophaga indicate that the animals live near the body of the bird. The barbules

near the base of the contour feathers lack the little hooklets which ordinarily hold the barbules together and thus present a more or less "fluffy" condition. It is to these barbules that the eggs are fastened, often to a bundle of from five to twenty. The eggs always lie with the cap toward the tip of the feather. Often many egg-shells are found on one feather.

Practically nothing is known of the egg-stage in Mallophaga, so an effort was made to determine something about it. In the first series of experiments, the louse eggs from freshly killed birds were transferred to an incubator, heated by electricity to a temperature of 35° C. with slight variations. Moisture also was supplied. Of the first lot of eggs all were hatched in nine days, as was the case also with the second lot. The third lot contained eighteen eggs, of which all but two hatched within eight days, the last one in fifteen days. The adult lice taken from the red-winged blackbird and kept in the same incubator began to lay eggs on the sixth day and continued until the eighteenth day.

The specimens from the sparrow did not lay until the nineteenth day. None of these eggs hatched, because the whole experiment was brought to an abrupt end by fire. In another series of experiments, twenty-eight adults were placed in an incubator at a temperature of 37° C. Three days later six eggs were laid. More were laid the next day. These eggs all hatched in eight days, and the young began feeding the day following birth. Eight days was the shortest period in which any eggs were found to hatch. The progress of the growth of the embryo could be watched through the shell of the egg. In five days the legs could be seen folded against the thorax. None of the young hatched ever became adult in captivity, though I believe that they can be reared to maturity.

Much interest is attached to the length of time the parasites will exist off the body of the host. Contrary to current opinion, they will live for weeks if the natural conditions are approximated. Of the several species used in these experiments, that from the English sparrow (*Nirmus vulgatus*) proved most hardy, with those from the red-wing and crow next in order. Of one

lot of *Nirmus vulgatus*. sixty per cent died in eleven days though some lived until the twenty-ninth day. A culture of Docophorus showed fifty per cent living after twenty-two days. Of a lot of immature specimens of *Nirmus vulgatus*, twenty per cent lived twenty-one days. Specimens from the English sparrow seemed to thrive equally well when placed on feathers of the red-winged blackbird. Many interesting phases of their ecology might be worked out.

Tests were made to see if there might be a reaction to light. Repeated trials did not disclose such sensitiveness. If specimens were placed in daylight at the same temperature (37° C.), they showed no particular tendency to seek the darkened end of the chamber. They do, however, show a reaction to temperature. In a chamber which had a temperature of 48° C. at one end and 35° C. at the other, the specimens migrated from the higher to the lower temperature at a rate of 4.5 cm. in eighteen hours. None of the specimens used in these experiments died, but if specimens were confined in a temperature of 48° C., they showed marked irritation and all died within a few hours, while the controls lived for weeks at 35° C.

During these experiments, an open dish of water was kept in the incubator with filter paper hung over the edge to facilitate evaporation. Those individuals which were supplied with additional moisture by means of feathers stuck in moist plaster lived no longer than the others. Since these insects feed and thrive and even lay eggs when subjected to strong light, change of food, and daily handling, if kept at a warm temperature, it would seem that temperature is a very important, if not the most important, factor in their environment.

Of the other habits of the Mallophaga, the feeding process is, perhaps, the most interesting.[1] If the insects were left for a few hours on a bare surface, and then transferred to a feather, they would commence to feed immediately, but oftentimes they would feed without being "starved." In seizing a barbule, which would be grasped near the point of attachment and

[1] In these observations the compound microscope was used constantly, although at times the binocular type was employed.

clipped off by the mandibles, the head of the insect was invariably turned toward the main shaft of the feather. The barbule was then passed into the mouth by means of the mandibles and the first pair of legs, which moved back and forth in line with the long axis of the body.

Sometimes the whole barbule was eaten without further cutting, but often it was divided into three or four pieces. In this case the barbule was passed into the mouth and crop for one-third of its length and then clipped with the mandibles. The time occupied in feeding was generally from three to six minutes. After feeding, the barbules can be plainly seen "corded" or piled in the crop of the insect. Feeding was never observed on any feather or part of feather except that near the base, which is quite fluffy or loosely constructed. The end of the barbules nearest the barb was always passed into the mouth first, possibly because otherwise the shape of the swollen joints of the barbules would make eating difficult, if not impossible. In some cases, the barbs were completely denuded of barbules.

It is evident, then, from this series of studies, that some species of Mallophaga are more hardy than others, at least when removed from the body of the host and all subjected to the same treatment. The species from the English sparrow proved most hardy of all, but no explanation of this fact can be offered at present. The evidence contradicts the statements of authorities in the literature that Mallophaga will live but four or five days when removed from the body of the host, even if conditions surrounding them approximate the natural state. Twenty-nine days was the maximum period of existence off the body of the host.

The length of the egg-stage varied; the minimum was eight days. In all probability temperature is the controlling factor in determining the length of the egg-stage.

No reaction to light was noted, but a marked response to changes in temperature was evident. The optimum temperature is evidently about 35° C. Slight changes seemed to produce no

appreciable effect, but a higher temperature (48° C.) caused death in a few hours.

It is a popular belief that bird lice subsist upon the blood of the host, but their mouth parts are in no way adapted to securing blood. They live entirely upon the feathers and scales of the body of the host.

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THE TIGER BEETLES (CICINDELIDAE) OF CHEBOYGAN AND EMMET COUNTIES, MICHIGAN[1]

FRANK N. BLANCHARD

The observations on which this paper is based were made in the vicinity of the Biological Station of the University of Michigan, on Douglas Lake, Cheboygan County, Michigan, during portions of the summers of 1916, 1917, and 1918. The purpose was to discover the composition of the cicindelid fauna of the region, and to learn something of the habits, and the habitat preferences and restrictions of the various species. It is possible that the first object has been attained, although there may yet be found some form not here recorded. As for the remainder of the program, only a very moderate degree of progress can be claimed. Satisfactory results on the whole problem can be attained only by two or more years of intensive work throughout the season of activity of the tiger beetles. Such a study should include the larval as well as the adult phases. Incomplete as the present work is, it may serve a purpose in calling attention to the need for fuller information on this conspicuous element of the fauna.

At the end of the article is appended an artificial key for identification of the tiger beetles known to occur in Cheboygan and Emmet counties. Descriptions and measurements are based upon specimens collected by the writer, and deposited in the Museum of Zoology of the University of Michigan. The nomenclature here adopted is taken from Leng, *Catalogue of the Coleoptera of America, North of Mexico* (1920).

The writer is much indebted to the Biological Station of the University of Michigan for every possible assistance in the prosecution of his studies. He also wishes to express his thanks

[1] A contribution from the Biological Station and the Zoological Laboratory of the University of Michigan.

to Professor Henry F. Wickham and to Mr. A. W. Andrews for identification of specimens, to Mrs. H. T. Gaige for drawings of the elytra of tiger beetles, and to Professor E. E. Calder for his opinion on *C. hirticollis hirticollis* and for the gift of two specimens of *C. hirticollis rhodensis* for comparison with his own material.

Fourteen named forms of tiger beetles are now known from Cheboygan and Emmet counties, Michigan. They are as follows:

1. Cicindela duodecim-guttata Dej.
2. Cicindela hirticollis hirticollis Say.
3. Cicindela hirticollis rhodensis Calder.
4. Cicindela longilàbris longilabris Say.
5. Cicindela patruela patruela Dej.
6. Cicindela punctulata punctulata Oliv.
7. Cicindela purpurea audubonii Lec.
8. Cicindela limbalis limbalis Klug.
9. Cicindela purpurea purpurea Oliv.
10. Cicindela repanda repanda Dej.
11. Cicindela scutellaris lecontei Hald.
12. Cicindela scutellaris modesta Dej.
13. Cicindela sexguttata sexguttata Fab.
14. Cicindela tranquebarica tranquebarica Herbst.

The tiger beetles common and abundant in this region, arranged in order of decreasing abundance, are as follows: *C. tranquebarica*, *C. repanda*, *C. limbalis*, *C. lecontei*, *C. patruela*, *C. duodecim-guttata*. Those that appear to be regular in occurrence, but limited in numbers, are, in decreasing order: *C. longilabris*, *C. punctulata*, *C. sexguttata*. Those that seem to be scarce are: *C. purpurea*, *C. audubonii*, *C. modesta*.

C. hirticpllis hirticollis and *C. hirticollis rhodensis* were taken only on the Lake Michigan beach, north of Harbor Springs, where both were common.

To determine the relative abundance of the species, it was not necessary to collect all the specimens seen, as they could be definitely identified at sight if approached within three or four feet. When an individual flew away too soon, it was

identified at the next stop; if it escaped without being identified, it was ignored completely, in hopes that the average would scarcely be affected; if there was any doubt about identity, the specimen was secured. There were relatively very few times when an individual made its escape without being identified.

From the first, it was evident that, so far as tiger beetles were concerned, the region could be divided into four major habitats, (1) pine land, (2) hardwood land, (3) sandy beaches of lakes and streams, (4) open sites that are low and adjacent to moist areas. It was clear, too, that in each of these environments one or more forms of tiger beetles found particularly favorable conditions. For purposes of study these habitats were still further subdivided, and on all field-excursions complete records were kept of all the tiger beetles identified, together with the particular sort of habitat in which each individual was found. From these records Table I has been compiled. The figures give the numbers of specimens actually identified in the major habitats. This shows the relative abundance of the commoner tiger beetles in the major environments and indicates, very clearly in most cases, the specific limitations in the local distribution of the forms.

TABLE I

CICINDELA	Pine Land		Hardwood Land	Sandy Beaches	Low, damp Land
	More open places, as roads	Less open places, as paths			
duodecim-guttata	...	...	..	40	113
lecontei	203	36	..	1	...
limbalis and purpurea	146	110	9	3	...
longilabris	13	8	9	...	...
patruela	56	100	..	1	...
punctulata	9	6	1	...	...
repanda	1	...	..	278	3
tranquebarica	259	28	53	41	23

These habitats and their cicindelid inhabitants may well be described in greater detail:

(1) The pine land, now lumbered and for the most part burned over, occupies the greatest area in the vicinity of the Biological Station. It is in general covered with aspen associations in various stages. Where the aspens are far apart and the ground most nearly exposed, that is, in places covered only by lichens, and along the footpaths and sandy roads, tiger beetles are plentiful. Those that seem to belong essentially to these situations are *C. patruela*, *C. lecontei*, and *C. limbalis*.

Of these the first is the most restricted in habitat. It is nearly confined to grassy roads and open places in the aspens. The second, while found commonly with *C. patruela*, is much more distinctly an inhabitant of the open, sandy places, especially roads. *C. limbalis* ranges freely and abundantly all through the aspen area, preferring, however, the open places. *C. tranquebarica*, while only occasionally taken along the trails and in open places in the aspens, competes in abundance elsewhere with the tiger beetles in all situations. On sandy roads it may be exceeded only by *C. lecontei*. *C. punctulata* is one of the less common kinds. This form seems to prefer the open, dry places.

(2) The hardwood land was less studied, since it is not well represented in the vicinity of the Biological Station. The only tiger beetle that could be considered very common there is *C. tranquebarica*. On an open road nine miles west of the Biological Station, where there is no pine land nearer than five miles, sixteen individuals of *C. tranquebarica* were counted, and no other species were seen. Although it was the fifth of September and very cool in the shade and wind, the sun was bright and hot, and the commonness of *C. tranquebarica* here leads me to think that it was not the weather, but the lack of conditions suitable for the other cicindelas, that explains their absence.

(3) Three tiger beetles are characteristic of the lake beaches, *C. repanda*, *C. tranquebarica*, and *C. duodecim-guttata*. The

first is by far the most abundant. (See Table I.) It was rarely taken except on sandy beaches, either of lake or river, and then only within a short distance of water. *C. duodecim-guttata* was unusual on broad beaches of dry sand, but occurred regularly on low, wet beaches, being found often, however, on the drier parts.

(4) *C. duodecim-guttata,* although closely related to *C. repanda*, is very different in habitat preference. It is common on roads of mixed sand and humus, that lie through low, wet or moist country not much overgrown with trees. If, however, but little soil is exposed except the road-bed, this species will be scarce. *C. tranquebarica* also occurs regularly in such places, but in much smaller numbers than *C. duodecim-guttata*.

From the preceding and from the notes following, it will be evident that it is possible, upon entering a new area, to predict just what species of tiger beetles will be found, and in about what proportion.

It was originally intended to make a study of the influence of weather conditions on the appearance and activities of the tiger beetles, but this investigation was not carried far enough for the formation of definite conclusions. Such observations as were made, however, indicate that, for the beach forms, *C. repanda* and *C. tranquebarica,* a temperature of 61° F. is too cold for them to be abroad; that they are more active when there is some wind than when there is none; that they are not abroad during rain, although there may be a few out as it starts; that they are most active and wary on bright, sunny days when the temperature ranges from about 75° to 95° in the air and from 85° to over 100° on the sand. A careful study of the influence of weather conditions promises interesting results.

The following notes on the several species of *Cicindela* occurring in this region are fragmentary at best, but it is hoped that their perusal will focus attention upon the many problems awaiting investigation.

C. DUODECIM-GUTTATA Dej. — Although this form is allied to *C. repanda* and at times approaches it closely in pattern, it appears to be definitely a different species. While from a description it may be difficult at times to separate them with certainty, one who is familiar with both need never be confused. *C. duodecim-guttata* is stouter and darker, and the middle band is partially or completely separated from the white of the outer edge of the elytron. An important distinction is the difference in habitat. *C. repanda* is abundant on sandy river and lake beaches, preferring the drier parts, or on roads adjacent to rivers and lakes, and is apparently only accidental in other places.

C. duodecim-guttata, on the other hand, while not uncommon on river and lake beaches, when in such places always prefers the moister parts. Its optimum habitat appears to be roads through, or adjacent to, low, moist, open areas, as meadows or marshes, when there are banks of exposed soil near; or low, moist lake or river beaches; or bare spots and exposed banks near rivers and brooks. It will be found where the soil has considerable humus, a distinct difference from *C. repanda*. In such situations it is by far the most abundant tiger beetle present. The only competing species are, first, *C. tranquebarica*, and second, *C. repanda*. No specimens were found in other habitats.

C. duodecim-guttata seems to be common throughout the summer. It was found to be common on the tenth of August, when *C. tranquebarica* was scarce and no *C. repanda* were seen on the beaches. In September, 1916, it was exceedingly abundant along the road from Ingleside, while in the same month a year later it was only moderately common there. September, 1916, was cold and rainy, following an unusually dry summer, while the summer of 1917 was more normal with respect to rain, and September was dry and warm.

This species commonly excavates burrows in bare soil near its hunting grounds. It seems always to select a slope, if only a gentle one, and to dig its tunnel downwards a little from the horizontal. The tunnels average about four inches in depth.

The digging of these tunnels must represent considerable labor, for a tiger beetle's legs are not well adapted for digging, and the soil, in this case at least, was hard-packed, red earth, sandy and mixed with pebbles. Four of these burrows were explored and each contained a *C. duodecim-guttata* at a depth of about three inches.

At another exposure near this, representing a typical *C. duodecim-guttata* habitat, at least twelve burrows were counted within a radius of a foot (September 20, 1916). There was a tiger beetle at the entrance in four instances. On my making a movement toward one, it flew away instead of retreating into the burrow, indicating that the burrow is not a place of refuge from pursuit. This fact was easily verified a number of times subsequently. Usually the burrows were seen in the daytime, but on one occasion they were visited at dusk (6 P.M., Sept. 16, 1917). Each was found closed at the surface with a heap of fresh sand. Two specimens were dug out from these plugged burrows. In each case, of course, the beetle was found at the extreme end, one of them at a depth of five inches. One burrow had no sand-plug, but an occupant was present at the entrance with only its head visible. The plug may serve to keep out intruders, such as ants and spiders.

It was not determined whether burrows were present during the whole season, but they were observed only late in the summer, and, if this is the general situation, it may be that the approach of cold weather serves as the prime stimulus to digging. They were used, when observed (September), as a refuge at night and in bad weather. In all probability they serve for hibernation as well. The same species was observed in burrows, near Ann Arbor, Michigan, both late in the autumn and early in the spring.

C. HIRTICOLLIS HIRTICOLLIS Say and C. HIRTICOLLIS RHODENSIS Calder.[2] — These forms were found to be very common and

[2] The specimens of this form were identified as *C. hirticollis rhodensis* Calder by Mr. A. W. Andrews, by comparison with specimens from the Great Lakes obtained from and identified by Mr. A. B. Wolcott, but

apparently associated together on the Lake Michigan beach, Emmet County, Michigan, July 16 and 17, 1917. I know no certain record of their having been found in the interior of Emmet or Cheboygan County.

C. LONGILABRIS LONGILABRIS Say. — This subspecies is about as common as *C. punctulata*, but its seasonal distribution is different. I have taken it regularly from June 25 to July 25, but from then until the middle of September it seems to be very scarce. In habitat it is less restricted than most of the other species. It is found in such places as paths in aspen and hardwood land where the trees are young and scattered, in open farm land, on sawdust piles, sometimes on roads, but not near water or wet places. It tolerates more shade than any other species in this region except *C. patruela*. One specimen, found on a partially shaded aspen trail, was eating an ant a quarter of an inch long, which was still alive.

C. PATRUELA PATRUELA Dej. — Although this subspecies is one of the most plentiful in the region, in habitat it is one of the most restricted. It is commonly found only in the sandy, aspen country, along bare or grass-covered roads, and along footpaths, and less frequently away from paths and roads. It has also been taken in grassy fields on the bare sandy spots adjacent to tree stumps. *C. patruela* will endure some shade, but, along the partly shaded paths, it is more commonly found in the sun. In such situations, it is usually the only tiger beetle present. This species, as has been noticed by others, is about

Mr. E. E. Calder is unwilling, after comparison with the type specimens, to regard this form as identical with his *C. hirticollis rhodensis*. He says that these specimens are "quite close, differing somewhat in size, degree of maculation, and also differ by being less hairy beneath. *C. rhodensis* is an ocean-beach form, occurring only on the Atlantic Coast. I am inclined to the placing of your specimens as a variety *C. hirticollis*." However, upon comparison of this form with two "typical specimens of *C. rhodensis*" submitted by Mr. Calder, I cannot consider them as differing even subspecifically. It is a well-known fact that many species of animals characteristic of the Atlantic Coast are found inland only on the Great Lakes, and this seems to be another instance.

the easiest one to catch. Its preference for thicker vegetation has accustomed it to shorter flights.

During the season of activity there are two distinct periods of abundance. The beetles were present in numbers on June 26, 1917, and from then until the last of July. After a period of scarcity of two or three weeks, they again appeared in large numbers during the latter part of August and in September. It seems probable that the emergence of adults in late summer varies from one season to another in dependence upon climatic conditions. In September, 1917, the adults were far more plentiful than in September, 1916. This fact may very well be correlated with the difference in the weather of these two months, since September, 1916, was almost entirely rainy and cold, while September, 1917, was unusually warm and dry. Specimens were seen *in coitu* June 26 and July 8, 1917. All of this indicates that the life cycle is the same as that of *C. sexguttata* (Shelford, 1908, 167–8).

C. PUNCTULATA PUNCTULATA Oliv. — Although of regular occurrence in this region, *C. punctulata* is by no means abundant. I have not taken it earlier than July 25, but from then on through September, it may be expected in suitable places. It has been found only in the sandy country, far from water, in such situations as hard, dry roads, sandy roads, footpaths through dry, grassy fields, roads partly grass-grown, and trails through sandy country with thin growths of young aspens and bracken ferns. It prefers situations somewhat more open than does *C. patruela*.

C. PURPUREA AUDUBONII Lec. — A single specimen (No. 228, Mus. Zool., Univ. of Mich.) of this form was taken July 8, 1917, on a partly grass-grown road through lumbered hardwood land northwest of Burt Lake. *C. limbalis* is found in such situations, but its optimum habitat in this region is the lumbered pine land.

C. LIMBALIS LIMBALIS Klug. and C. PURPUREA PURPUREA Oliv. — As these two forms are doubtfully distinct and have not

for the most part been separated in observation, they are here treated together. No distinctive difference was noted in habitat preferences. The habitat of *C. limbalis* is much the same as that of *C. patruela* with these differences: it is commoner than the latter on the sandy roads in the aspens; along the footpaths it occurs in the more exposed places, while *C. patruela* is frequent even in the parts where vegetation is rather high and even where there is shade; when flushed, it more often alights again on the trail, while *C. patruela* does not, as a rule, return.

Furthermore, *C. limbalis* was not infrequently found in similar situations in hardwood land. It is thus less restricted in habitat than *C. patruela*, and has greater preference for the more open places. It does not appear to be the dominant tiger beetle in any habitat, unless its habitat may be considered intermediate between the open, sandy roads and the partly shaded footpaths. There are distinctly two periods of abundance, separated by a period of scarcity in August. Individuals were seen *in coitu* June 30, 1917.

Specimens were taken with the apical lunule complete, middle band sinuous and reaching the margin, and humeral and posthumeral dots conspicuous (*C. limbalis limbalis*); others were taken with the markings reduced to only a very small apical dot, and a thin, straight middle band (less than a millimeter long) in the position of the discal spot (*C. purpurea purpurea*), but the greater number lay between these extremes, and nearer to *C. limbalis limbalis*. Green forms were taken that answer to the description of *C. limbalis spreta*, but these are probably only individuals newly emerged (Shelford, 1917, 48, Plate 31). A single black specimen was captured (*C. purpurea audubonii*). Although at least four named varieties can be found among the insects taken, it seems very doubtful to the writer whether these can represent more than a single valid subspecies. Closer observations on habitat preferences might throw light on the question.

C. REPANDA REPANDA Dej. — From a printed description, one may easily confuse this form with *C. hirticollis hirticollis*.

It is, however, a smaller beetle; its elytral markings are quite distinct (See description of *C. hirticollis* at the end of the paper); and the shape of the body is somewhat different, especially in the case of the male. I have not studied *C. hirticollis* sufficiently to explain the habitat differences of the two species, but it is worth noting that both *C. repanda* and *C. hirticollis* occur on the Lake Michigan beach of Emmet County, along with *C. rhodensis*, while along the smaller, inland lakes I have seen no specimen of *C. hirticollis*, although *C. repanda* is abundant. The differences between *C. repanda* and *C. duodecim-guttata* have been stated under the discussion of the latter form.

Although one of the most abundant tiger beetles of this region, *C. repanda* is practically confined to the lake beaches. It is common and abundant on the beaches of Douglas, Burt, and Mullet lakes, and along all the smaller lakes that have sandy shores. Usually it is found on the drier parts of the beaches, but it does not hesitate to hunt near the water's edge. Among the numerous tiger beetles of this region, *C. repanda* ranks second in abundance, being surpassed by the widely ranging *C. tranquebarica*. On the lake beaches, however, it is by far the commonest form of the genus; the only others ordinarily present are *C. tranquebarica* and *C. duodecim-guttata*.

Sandy river banks are but poorly developed here and are not readily accessible, but in one such place on Maple River, at least half a mile from any road, lake beach, or bare ground, the only tiger beetles present were three specimens of *C. repanda*. It is only rarely that this species is found in situations other than these mentioned. It may, apparently, be taken in numbers at any time in the summer, except during the first half of August, when it seems to be scarce.

C. repanda commonly digs burrows in the sand to rest in. I had one particularly favorable opportunity to study the burrows. At the west end of Douglas Lake, a little-used road meets the shore at right angles. About 50 to 150 feet from the lake shore, this road crosses a low ridge of sand of precisely the same quality as beach sand. At one side of the road is a ditch that was partly filled with water (September, 1917), and

on both sides were sandy banks from one to four feet high. Here *C. repanda* was present in great abundance.

The only other kind of tiger beetle seen in the vicinity was a single specimen of *C. duodecim-guttata*. In one small area on a slope there were twenty burrows, and digging operations were going on in at least six of them. A few days later these burrows had all been destroyed by rain. The opening of the burrow is nearly semi-circular; its long axis is oriented only approximately perpendicular to the dip of the slope. The burrow slants down from the horizontal at an angle varying from perhaps 30 to 45 degrees. There appear to be no bends or side branches. The length of the burrows was measured by thrusting in a slender stem of a plant. Six measurements of different burrows gave these figures in inches: 4, 3½, 4, 3, 4¾, 5, an average of four inches. This is doubtless low, since digging was still in progress in some of the holes (Criddle, 1907, 111, records them much deeper).

The insect digs with the middle and posterior legs of one side, resting meanwhile on the other four, with the abdomen pointed at a moderate angle toward the side of the burrow farthest from the digging legs. After digging for one to two seconds with one group of legs, the beetle may immediately use the other pair, then rest two or three seconds, or, more often, it may rest after each effort. The digging motion throws some of the sand under the abdomen, and the rest of it backward in a fine stream. After digging on one side, it moves back a little, toward the entrance of the hole, and the abdomen is directed toward the other side of the burrow. Thus the pile of sand is moved outward. The beetle works in this way until its body, except the head, or sometimes until its entire body, is outside the hole.

There is usually a pause at this point although not always. After resting, the beetle retreats into the burrow, to reappear in a minute or so with another load of sand. The sand is thus collected in a semi-circular ridge, about the length of its body from the entrance.

C. repanda may sometimes be found in the sand where there

is no indication of a burrow. It may have crawled in without making a tunnel, but in each case observed, the beetle has entered the sand only by digging in and leaving a hole open to the outside or conspicuously plugged with a pile of sand. If it entered by the latter method, the opening may have been obliterated by rain or wind, and the beetle may then have remained buried until the heat of the sun was sufficient to induce it to come out.

At this same place where *C. repanda* burrows were encountered in such abundance in September, 1917, the same condition was found in September, 1918. The ditch at the roadside was dry and in its bed *C. repanda* was present in abundance, being the only tiger beetle there. I quote from my notes on their habits at this time: "They are almost constantly on the move, traveling by a rapid walk or run for a distance of a fraction of an inch up to two or three inches, stopping for a second or two or for several seconds, and then starting off again. If a small fly is sighted, the tiger beetle will make for it by a long run or by a series of short runs with almost no pauses. In the cases I watched, the fly was always too quick to be caught.

"A large ant crossed the sand. As it is not infrequent to find an ant's head clasping with its jaws an antenna of a tiger beetle, I thought ants must be common food of tiger beetles, and I watched to see if this ant would be caught. A tiger beetle ran up to the ant from behind, but did not molest it; one or two other beetles did likewise. The ant proceeded on its way as if nothing was happening. To see if a disabled ant would be eaten, such a one was thrown on the sand amongst the beetles. It attracted much attention. A tiger beetle ran up to it and without using its jaws or pausing more than a second, hurried off a little distance, paused, returned part way, turned, and went off. The ant struggled, but could not walk.

"Many other tiger beetles behaved similarly. Once in a while, one would catch the ant and move off a little, but each gave it up very soon. A crane-fly was caught and thrown on the sand. Very soon a tiger beetle took it and brought it up

amongst the grass to within three inches of my hand, and there ate it, head first, until frightened by a movement. The remains of the crane-fly, when thrown on the sand, were soon seized by another tiger beetle and eaten. It seems that the tiger beetles are not eager to engage an insect that is able to defend itself."

For September 14, 1916, I have the following note on the feeding of some specimens of *C. repanda* in a large, covered, glass dish. "I put in two flies from each of which I had removed a wing. *C. repanda* soon seized one by the abdomen, chewed it and dropped it repeatedly, then tore off a part of the abdomen and swallowed it, with much chewing with the mandibles, moving of the palps, and brushing of the elytra with the hind pair of legs, slightly elevating the abdomen and the elytra during the process. When the fly was half-eaten, the tiger beetle pranced around the dish awhile as if in high spirits; then returned to the fly, and chewed and swallowed all but the eyes and a fragment of the thorax and of a wing. It cleaned its jaws with sand. After running about, stopping, and starting to dig under a chip, it suddenly pounced on the other fly and mutilated its abdomen by chewing viciously at it several times, and then left it half-dead."

C. SCUTELLARIS LECONTEI Hald. — This form is confined to the dry, sandy country. Its optimum habitat appears to be the open sandy roads. In such places it is exceeded in numbers, at times, only by *C. tranquebarica*. It is also common in the most open, sandy, aspen country, where there are small areas without trees or small shrubs, and along paths exposed to the sun. Although this is one of the most abundant tiger beetles in the region, it was never taken near water or moist sites, except for a single specimen collected on the Douglas Lake beach (Sept. 8, 1917).

This species is very abundant in late June and July, scarce in late July and early August, and yet most abundant in late August and early September. Specimens were observed *in coitu* in 1917 on June 30, and on July 3 and 8. Of the other species of tiger beetles collected, the numbers were about

equally divided between the sexes, but in the case of *C. lecontei*, only about one-third as many males were collected as females. This may, however, have been only a matter of chance.

A few individuals were dug from burrows in the side of wheel ruts on sandy roads. One specimen was exhumed from a burrow, September 11, 1917, on an abandoned railroad grade remote from water. The burrow was about half-way up a slope of about 20 degrees, facing west. It entered the ground at a gentle dip from the horizontal. The opening was elongate-oval above, straighter below, with a sand pile on the lower side, very similar, in fact, in appearance to the burrow of *C. repanda*, but made in a yellowish or brownish sand containing more fine, earthy material. This is probably the sort of burrow in which the adult hibernates. A specimen was taken, with the head of an ant clutching the left antenna near its base. It had probably eaten the rest of the ant.

This species varies in color from green to bronze. In early September, the period of emergence, the green forms are especially common. The first emergence probably takes place in early or middle June. The white markings are prominent and fairly constant in extent, but in none of the specimens taken were they connected at the sides.

C. SCUTELLARIS MODESTA Dej. — A single specimen referable to this name was taken July 8, 1917, on a sandy road partly grown up with grass, in hard-wood country, about a mile northwest of Burt Lake. Many specimens typical of *C. lecontei* were found on the same day in the same situation. Shelford (1917, 46–47) has shown that this black form which occurs as a part of the general population with the green merely lacks the metallic surface film. That it represents a true subspecies seems, therefore, doubtful, but the matter is one yet to be determined.

C. SEXGUTTATA SEXGUTTATA Fab. — The only authentic record of the occurrence of this subspecies rests upon three specimens taken on July 8, 1917, northwest of Burt Lake.

They were on a partially grassy road through lumbered hardwood land. In the vicinity of Ann Arbor they are common in such situations. It is to be noted that in no instance was *C. patruela* found in hardwood land in the Douglas Lake region. These two species, although evidently closely allied, may prove to be as distinct in habitat preferences as *C. duodecim-guttata* and *C. repanda.*

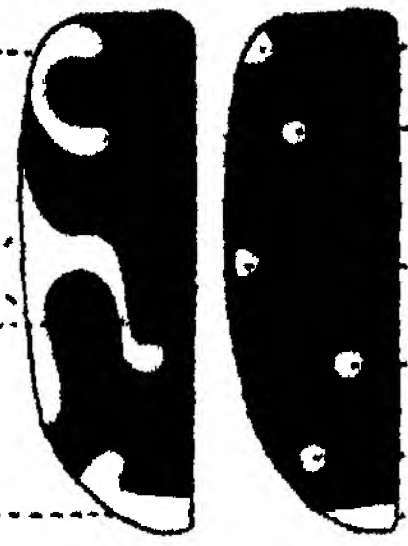
C. TRANQUEBARICA TRANQUEBARICA Herbst. — This tiger beetle is the most abundant in the region, and the least restricted to a particular habitat. On the lake beaches it is less common than *C. repanda*, but more so than *C. duodecim-guttata.* The relative numbers of the three are expressed approximately by the figures 20, 4, and 1. In the habitat of *C. duodecim-guttata,* it numbers about one-sixth of the population. On sandy roads in the aspens *C. tranquebarica* is equaled in numbers only by *C. lecontei.* In open situations in hardwood land, such as roads, it is the most common tiger beetle present.

In the aspens, it is distinctly noticeable that this species diminishes in numbers with increase in vegetation. On footpaths, where *C. patruela* is most common, *C. tranquebarica* is almost non-existent. Its habitat preference may be summed up by saying that it is common on sunny, unvegetated places, irrespective of the kind of soil. It is, however, usually secondary in numbers to the species in whose particular habitat it is found.

Although this species may be found throughout the season, there are two distinct periods of abundance, as in the case of *C. patruela.* Unlike the latter, however, it appears to be less sensitive to unfavorable weather conditions, for no marked difference in numbers of the late summer brood was noted between the years 1916 and 1917, as was the case with *C. patruela.*

The accompanying diagram will explain the special terms used in the following key.

DIAGRAM OF ELYTRAL MARKINGS OF TIGER BEETLES



ARTIFICIAL KEY TO THE TIGER BEETLES (CICINDELA) OF CHEBOYGAN AND EMMET COUNTIES, MICHIGAN

a^1. Outer lateral edge of elytron green (or blue), distinctly marked off from the remainder, which may be green, purple, or reddish brown .... *C. purpurea.*

b^1. Middle band thin, reduced, straight; anteapical dot absent or very faint ....9. *C. purpurea purpurea.*

b^2. Middle band prominent, curved; anteapical dot distinct. 8. *C. purpurea limbalis.*

a^2. Outer lateral edge of elytron not green, nor differently colored from the remainder.

c^1. Middle band complete.

d^1. Humeral lunule complete.

e^1. Elytra bright green ....5. *C. patruela patruela.*

e^2. Elytra dark bronze to black.

f^1. Elytral markings more or less broken into dots; posthumeral dot round, or, rarely, humeral lunule complete...................1. *C. duodecim-guttata.*

f^2. Elytral markings not at all broken into dots, or, if abnormally so, posthumeral dot long and diagonal to the elytral suture.

g^1. Marginal line represented only by a slight basal expansion of middle band. 14. *C. tranquebarica tranquebarica.*

g^2. Marginal line complete.

h^1. Humeral lunule bent slightly forward at a distinct angle with margin. 2. *C. hirticollis hirticollis.*

h^2. Humeral lunule extending out from margin in a smooth curve, sometimes bent forward at extremity............... 10. *C. repanda repanda.*

d². Humeral lunule broken into dots or absent.
 i¹. Apical dot absent ....4. *C. longilabris longilabris.*
 i². Apical dot present.
  j¹. Black beneath...............7. *C. purpurea audubonii.*
  j². Metallic green or blue beneath.
   k¹. Elytra dark brown to brownish black.
1. *C. duodecim-guttata.*
   k². Elytra bright green...........5. *C. patruela patruela.*

c³. Middle band incomplete.
 l¹. A row of green dots, visible without lens, near sutural line and parallel to it, on each elytron; elytra dark brownish or blackish; white markings much reduced or absent; body small and slender.
6. *C. punctulata punctulata.*
 l². Rows of green dots not present.
  m¹. Black, beneath................12. *C. scutellaris modesta.*
  m². Blue or green beneath.
   n¹. Above, bright metallic blue, green, purple, or bronze.
    o¹. Humeral and posthumeral dots absent; discal dot usually distinct; elytra brilliant green or blue (blue when viewed against the light).....................13. *C. sexguttata sexguttata.*
    o². Either humeral or posthumeral, or both dots present; discal dot absent; elytra metallic green, purple, or bronze (purple when viewed against the light)......11. *C. scutellaris lecontei.*
   n². Above, dark bronze to blackish.
    p¹. Markings on elytra nearly or quite absent, except along margins........3. *C. hirticollis rhodensis.*
    p². Markings on elytra more or less broken into dots.
     q¹. Posthumeral spot a long, diagonal dash.
14. *C. tranquebarica tranquebarica.*
     q². Posthumeral spot a roundish dot, or short and curved...................1. *C. duodecim-guttata.*

1. C. DUODECIM-GUTTATA Dej. — Brownish-bronze to black; elytral markings more or less broken into dots, never entirely complete as in *C. repanda;* the apical lunule marking most constantly broken; marginal line never nearly meeting the humeral lunule. Length, 10½–13 mm.

Damp roads, and moist river, brook, and lake beaches. Common on the road from Ingleside.

2. C. HIRTICOLLIS HIRTICOLLIS Say. — Brownish-bronze above; elytral markings complete; marginal line joined with humeral lunule; latter, at distal end, extending distinctly forward at an angle with the margin; elytral markings more slender than on *C. repanda;* front, thorax, and ventral parts more hairy than *C. repanda.* Elytra of females suddenly dilated before the middle, of males but slightly and gradually widened. 13–14 mm.

Taken only on Lake Michigan beach, Emmet County.

3. C. HIRTICOLLIS RHODENSIS Calder. — Brownish-bronze above; elytral markings very faint or absent, occasionally present along margins of elytra, at times a discal spot. Elytra of females suddenly enlarged before the middle, of males but slightly and gradually widened. 12–14 mm.

Taken only on Lake Michigan beach, Emmet County.

4. C. LONGILABRIS LONGILABRIS Say. — Very dark brown to black; middle band complete, narrow, and sharply bent; humeral, posthumeral, and anteapical dots present; apical dot absent; front of head without hairs; between the eyes parallel ridges, conspicuous with lens. 12–15 mm.

More or less open situations, away from water.

5. C. PATRUELA PATRUELA Dej. — Bright green (dried specimens may be deep blue, especially viewed against the light); middle band complete, slightly expanded at the margin; humeral and apical lunules complete or broken; front of head hairy; beneath much more hairy than *C. sexguttata.* Robust; 12–14 mm.

Roads and paths in aspens.

6. C. PUNCTULATA PUNCTULATA Oliv. — Bluish-black above; elytral markings much reduced; apical lunule present but thin;

fragments of humeral lunule and middle band sometimes present; a row of green spots near to and paralleling elytral suture on each side; front of head smooth, except for a few hairs near eyes. Form slender; 11–12 mm.

Occasional on dry roads and paths.

7. C. PURPUREA AUDUBONII Lec. — Black above and beneath; markings and proportions like *C. purpurea limbalis.* Only one specimen taken; this has well-developed, curved middle band, apical lunule, and humeral and posthumeral dots. Length, 12 mm.

8. C. LIMBALIS LIMBALIS Klug. — Green, purplish, or cupreous; lateral margins of elytra green or blue, distinct from remainder; middle band sinuate, complete, extending to outer margin; apical dot always present, anteapical usually, and humeral and posthumeral dots sometimes present. 11–14 mm. (This form not sufficiently distinct from *C. purpurea purpurea.*)

Roads and paths in aspens.

9. C. PURPUREA PURPUREA Oliv. — Color like *C. limbalis limbalis;* middle band short, scarcely or not at all sinuate, not reaching margin; markings reduced, some individuals retaining only a small apical dot, and a short, thin, straight line representing distal end of middle band. (Not sharply marked off from *C. limbalis limbalis.*) 12–13 mm.

Roads and paths in aspens, also roads on hardwood land.

10. C. REPANDA REPANDA Dej. — Brown-bronze above, green or blue beneath; markings complete; about half the individuals have humeral lunule connected at side with marginal line. Elytra of females abruptly dilated before the middle, of males nearly parallel. Males, 11–12 mm; females, 11½–12½ mm.

The commonest tiger beetle on sandy lake beaches; never far from water.

11. C. SCUTELLARIS LECONTEI Hald. — Green, purple, or bronze; middle band and discal dot never present; marginal dot

much or but little expanded on margin; humeral lunule complete, broken, or entirely absent; apical lunule usually complete, sometimes broken. Small, robust; 10½–12 mm.

Very common on roads and paths in aspens.

12. C. SCUTELLARIS MODESTA Dej. — Black above and beneath; form and markings like *C. lecontei*. Only a single specimen taken.

13. C. SEXGUTTATA SEXGUTTATA Fab. — Green or blue (bluer after drying); front of head without hairs, except a very few near the eyes; only slightly hairy beneath; middle band represented by marginal and often by very small discal spot; no humeral markings on specimens examined; apical and anteapical dots usually present. Smaller than *C. patruela* and more slender; 12–13 mm.

Partly shaded paths, and roads in woods, probably avoiding sandy country.

14. C. TRANQUEBARICA TRANQUEBARICA Herbst. — Blackish bronze to black; humeral lunule prolonged backwards as a diagonal dash; markings complete, except middle band but slightly expanded on margin, and, rarely, humeral lunule or middle band broken; hairy below and on front of head. 13–15½ mm.

Common on roads and beaches.

GENERAL CONSIDERATIONS

Fragmentary and unsatisfactory as is the character of this present work on the cicindelids, it cannot help drawing attention to the many attractive features, for a local study, possessed by the genus *Cicindela,* and suggesting some of the innumerable problems awaiting solution. Many of these can be settled by well-directed observation during a single season, others, however, require continued observation throughout the season of activity and should preferably be verified by a second year of study.

Some of the features making this a favorable genus for study are: (1) abundance of individuals, (2) diversity of forms or species, (3) ease of observation for study of habits, (4) diversity of life-histories, (5) ease of keeping in captivity, (6) extent of individual variation in readily observable characters, (7) definiteness of response to environmental conditions, and (8) abundance and availability of literature dealing with the genus. In view of all these advantages, it is surprising that the tiger beetles have been so completely neglected during the fourteen years of the existence of the Biological Station in this region.

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DATA ON THE DISTRIBUTION OF MICHIGAN FRESH-WATER SPONGES *

FRANK SMITH

Very little has been published on the fresh-water sponges of Michigan. Reighard reported an unidentified species of Ephydatia, found in Lake St. Clair in 1893. Adams reported *Spongilla lacustris*, found in a creek in Ontonagon County in the Upper Peninsula in 1904; and the same species, found in shallow water near the head of Rock Harbor on Isle Royale in 1905. In 1916 Hankinson reported *Spongilla fragilis*, *S. lacustris*, and *Meyenia fluviatilis astrosperma* (= *Ephydatia mülleri*), from Chippewa County; and *Spongilla fragilis* and *S. lacustris*, from Houghton County.

In the *Seventeenth Report of the Michigan Academy of Science* (1916), there is a list of certain groups of invertebrates found and studied in the summers of 1911–1914 by the present writer and Bessie R. Green, in the vicinity of Douglas Lake in Cheboygan County. This list includes nine species of sponges, found in creeks and ponds in the vicinity of the lake, although but one has thus far been found in the lake itself. The list is as follows: *Spongilla fragilis*, *S. lacustris*, *Ephydatia fluviatilis*, *E. mülleri*, *Heteromeyenia argyrosperma*, *H. repens*, *H. ryderi*, *Carterius tubisperma*, and *Tubella pennsylvanica*.

The inclusion of *Ephydatia fluviatilis* in the list was tentative and was based on specimens which varied essentially from the usual representatives of the species. More recently, normal representatives of the species have been found in the same vicinity, and it now seems advisable to consider the doubtful forms as representing an undescribed species of a genus other than Ephydatia. The description of this new form has not yet been prepared.

* Contribution from the Zoölogical Laboratory of the University of Illinois, No. 213, and from the University of Michigan Biological Station.

In the writer's collections, obtained from different parts of Michigan and not mentioned above, are the following items: *Spongilla fragilis*, from Pentwater, the Grand River at Grand Haven, and the Huron River at Ann Arbor; *S. lacustris*, from the Grand River at Grand Haven; *Ephydatia mülleri*, from a pond at Presque Isle, and from Black Lake near Macatawa; and *Heteromeyenia repens*, from Black Lake near Macatawa, and the Huron River at Ann Arbor. The Huron River specimens were collected by Dr. A. F. Shull.

In the collections of the United States National Museum are specimens of *Ephydatia crateriformis*, collected from the mouth of the Shiawassee River, received from Harlan I. Smith, and identified by Edward Potts.

Of the ten described species listed above, *Heteromeyenia argyrosperma* has been found in Nova Scotia and in a half-dozen states, of which the westernmost is Wisconsin; *H. repens*, *H. ryderi*, and *Carterius tubisperma* have been found in different parts of North America and also in Europe; while the remaining six species are each known from North America, Europe, and Asia.

It is a matter of some interest to compare the Michigan list with those of neighboring states. One slight difficulty in making such comparisons arises from the fact that the investigators chiefly responsible for the lists in Ohio, Indiana, and Wisconsin have followed the lead of Potts in failing to distinguish *Ephydatia fluviatilis* and *E. mülleri* as distinct species. It is quite probable that both of these species occur in each of the three states named, but appear in the lists under the one species name *Ephydatia fluviatilis*. Assuming this to be true, we find that the Wisconsin list includes all of the described Michigan species and in addition has *Spongilla igloviformis* and *Carterius latitentus*.

The Illinois list of twelve species includes all of the Michigan list except two, and has in addition *C. latitentus* and three other species of more southern distribution, and not yet found as far north as Michigan. Indiana has a list of nine species, which includes *C. latitentus* and eight other species which are

also in the Michigan list. Ohio has a list of eleven species which lacks the three species of Heteromeyenia, but includes *C. latitentus* and certain species of more southern distribution. *C. latitentus* is represented in all four of the adjoining states, and it seems highly probable that it will eventually be found in southern Michigan. *Spongilla igloviformis* may also be found within the borders of the State.

There is abundant evidence that more favorable conditions for an abundant sponge fauna are present in small bodies of water where there is not much wave action and where there is little or no silt. Enough current for circulation and a renewal of the food supply is desirable, but only a few species thrive where the current is strong. Sloughs, and channels which connect lakes, are often favorable habitats. The two localities in the Douglas Lake vicinity which have the richest sponge fauna are two small bodies of water in each of which are seven species, and two of these are not as yet known to occur elsewhere in the State. These localities are several miles apart, but each of them is in what has the appearance of having been a channel which was probably the outlet of a lake, now nearly filled up.

From what has preceded, it is evident that very little has thus far been done in a study of the sponge fauna of the State. For anyone who may feel disposed to undertake the making of collections, a few hints may be helpful:

(*a*) Gemmules are essential for recognition of the species and hence there is little use in collecting specimens in which they are not present. The gemmules are small seed-like bodies, visible to the naked eye, and easily recognizable with a hand lens.

(*b*) Sponges are commonly found on the surfaces of submerged logs, brush, coarse vegetation, and even on stones, and are more common in small ponds or streams, in relatively quiet, open water.

(*c*) Satisfactory specimens for subsequent study may be prepared by suspending the specimens in the shade, and in a current of air where they may dry out quickly, and retain

their color better than when exposed to the direct rays of the sun. Small specimens may be preserved in alcohol. Data of habitat, locality, and date of collection are important.

The following table shows our present knowledge of the distribution of sponges in Michigan and neighboring states. So far as now known, Asteromeyenia and Trochospongilla have a more southern distribution.

TABLE SHOWING THE DISTRIBUTION OF SPONGES IN MICHIGAN AND NEIGHBORING STATES

	Mich.	Wisc.	Ill.	Ind.	Ohio
Spongilla fragilis	+	+	+	+	+
" lacustris	+	+	+		+
" igloviformis		+			
Ephydatia fluviatilis	+	+?	+	+?	+?
" mülleri	+	+	+	+	+
" crateriformis	+	+	+	+	+
Heteromeyenia argyrosperma	+	+	+	+	
" repens	+	+	+	+	
" ryderi	+	+		+	
Carterius tubisperma	+	+	+	+	+
" latitentus		+	+	+	+
" tenosperma					+
Tubella pennsylvanica	+	+			+
Asteromeyenia radiospiculata			+		+
Trochospongilla leidyi			+		+
" horrida			+		

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